A Saga of RTS Systems, The Intercom Company

1988~1989 OUTSTANDING ACHIEVEMENT IN ENGINEERING DEVELOPMENT

IN RECOGNITION OF THEIR ENGINEERING CONTRIBUTION AND DEVELOPMENT OF PROFESSIONAL TWO WIRE INTERCOMMUNICATIONS SYSTEMS FOR USE IN TELEVISION PRODUCTION AND BROADCAST OPERATIONS

A Saga of RTS Systems, the Intercom Company

By Stan Hubler & Doug Leighton RTS Systems Cofounders

RTS™SAGA May 1, 2014

Belt Pack, BP325, ca 1991 & 2012

Master Station, Model 803, ca 1996

Belt Pack, BP300, ca 1980

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Preface

This book has several goals: an early history of RTS Systems, a description of some of the systems that RTS created, a description of the products that made up the systems, individual unit specifications, a technical description of selected products, insight into some of the key circuitry, pictures of the products, picture of the startup garage, and other pictures. This book is roughly, but not exactly, in chronologically order. Also, what do the letters RTS stand for? It was the first logo,(see Page 55) which became the company name.

Some Early RTS Systems History:
Three guys started RTS Systems in a garage in 1975. The company was successful because: it created "breakthrough" products; it had an excellent marketing program; and it kept creating new products. The founders were Douglas Leighton, President, Stan Hubler, engineer, and Rick Karwoski, engineer, (a previous Stan Hubler associate). Doug worked closely with engineering to bring forth the new products. Early on, Rick left the company.

1.) The "breakthrough" products made up a communication system used in television production. This system *replaced* a system patched together with telephone headsets, adapter boxes, and cables. This old system barely worked with very few stations connected together. Initially this *new* intercom system consisted of user Stations, power supplies, headsets, and microphone cable. The microphone cable was supplied by the buyer/user. The initial breakthrough was a multi-channel multi-user party line intercom audio system with up to 50 stations with good clean audio as loud as the user wanted. The system was easy to use: just plug it in, plug in your headset, select a channel, turn up the volume, turn on the talk switch when you want to talk.

2.) The excellent marketing consisted of full color page ads, brilliantly created by Douglas Leighton year after year. The ads appeared in the television press, and later, great word of mouth marketing because the product was just what the industry needed. Besides the marketing, Doug, the president, created the look and functions of all the products.

3.) Some of the follow-on new products included: more headset User Stations in many different configurations, Speaker User Stations, an IFB system (Interruptible FeedBack System) for the television talent, multichannel Master Stations, a Source Assign Panel that with additional power supplies resulted in an expansion of the number of channels to 16, a Break Out Panel to connect the Source Assign Panel to the multichannel intercom system, and a 5 way splitter box.

In addition, initially, RTS Systems created adapter modules to modify the television camera intercom to be compatible with the RTS Systems' technology. But later, the camera manufacturers built in the RTS Systems electronics.

Our customers expected the system never to fail no matter how they tortured it. As it turned out, we designed and built a lot of reserve in the system. This made the system continue to operate under very difficult conditions, and increased the reputation of the company.

Our Customers, The Intercom Users

In the Control Room are:

Producer: Handles the logistic and the personnel, is over the Director.

Director: Runs the rehearsals and the show, "The Show Boss"

Assistant Director: Coordinates the commercial breaks.

Technical Director: Handles the camera operators, switches the cameras.

Outside of the Control Room are:

The Camera Operators: Operate the television cameras.

The Audio Mixer: switches and sets levels on audio sources, usually to follow the cameras, is the head man for the audio crew. Is often isolated in a special room.

The A2: Supports the Audio Mixer and sometimes has a crew to manage.

The Announcer: Tucked away in a tiny little room, sometimes sound proofed.

The Video Person: Yet in a special space where he can monitor the cameras before and during the show and makes running adjustments to the cameras'pictures.

The Stage Director: Cues the talent/actors/actresses.

The Lighting Director: Directs light board operator, coordinates spotlights.

Wireless Coordinator: Coordinates wireless microphones/wireless intercom.

Recording operator: Sets up and runs recording devices.

Sports: Additional Personnel: Instant Playback crew, Color Announcer, on line video editors, Red Hat (On the playing field, coordinates the on-air commercials, with the play action on the field), Uplink coordinator**.**
IFB Users: Actors, Actresses, News Commentators, The "Talent".

The Beginnings

Early Days

It was the mid 1970s. It was the days of television classic shows. Broadcast television was in its heyday. Yet, technically, things were primitive compared to the present (2013). Cameras were still vacuum tube driven. It took hours to set the cameras up and match the colors. And the intercom systems were also primitive, derivatives of earlier telephone equipment. Telephone operator headsets ruled the day with various transistor hybrids, "retard coils" and poor performance. They did, however, hook together with just two wires (some systems, at least).

Douglas Leighton was working in television production and dealing with the old telephone style intercom. Doug was aware of the limitations of the telephone intercom, but he is a very creative person and thought up the way the intercom should be with some very significant key concepts. Doug thought, it's got to be practical, easy to build, easy to use, clear audio, but loud as you want, low cost, simple. Instead of extreme perfection, he needed practical excellence, and some good electronics people to make it happen. By chance he met Rick Karwoski, an electronic engineer, who by chance, worked with me at an aerospace company.

Getting Started

As soon as Rick accepted Doug's offer, he thought he would get some additional help to move the project faster. Also, Rick was working full time and working on his Master's degree, too. He needed some help so he gave me a call to come and help him. On August 14, 1975. Doug, Rick and I met in Rick's apartment to start the project. During our discussions, Doug would emphasize the word "systems" in "RTS Systems", the name of the new company. As it turned out that was what our products really were. Our first system would consist of User Stations, a central Power Supply, microphone cables and headsets. The microphone cables were specified because most of our potential clients had a significant supply of microphone cables. Because we planned on using microphone cable, we made the male and female connectors opposite to the cables that actually connected microphones, to prevent plugging a microphone into the DC on the intercom. Some of the items discussed were system DC voltage, system audio impedance, system signal levels, distances of stations from the power supply, the design goal of the maximum number of stations in a system, and the use of the system in a loud environment such as athletic contests and rock concerts. Doug also mentioned the system should be simple, reasonable cost, and very, very reliable.

We hammered out some of the basic system concepts and, after some further thoughts, here they are, on the next page.

The "TW" System Basic Concepts

1) We want to create a new party line or conferencing-type full duplex intercom system. A party line/ conferencing system allows all user stations to hear the same thing which is usually the director of the operation giving instructions, or asking questions. In the case of the questions, all stations can hear the reply as well. Full duplex means that all sides of conversations between two or more stations can be heard. For example, one station can interrupt the other at any time. But, in general, only the director's microphone is open, unless someone is asking or answering a question.

2) The system that would support as many as 50 user stations. The difference in level between a system with two user stations and 50 user stations would be only 6dB or about the same as the level change when one picks up an extension telephone to join an existing two way conversation. Also the volume control in each user station would require a minor adjustment in this case. Later on the system could be expanded to 16 or more channels.

3) Just two wires would support a single channel of operation. Adding another wire can give us a second channel. The desired cabling was *standard* 3-conductor microphone cable with XLR-3 style connectors on either end. (Microphone cable was something our customers have plenty of). The desired wire gage was 22 AWG (American Wire Gage), practically speaking the system had to also work on 24 gage. The wire gage affected long distance operations, (say 500 to 2500 feet). The original design was two channels but with additional plug in additions, it was expandable up to 16 channels.

4) A system network would consist of a central power supply, connecting cables, two or more user stations and headsets or speaker/microphones. Later on, some user stations would include their own power supply, but still talk and listen on the network.

5) A system impedance of 200 ohms. This implies that the system power supplies would supply the DC power but still have an audio impedance of 200 ohms over the audio band of interest: for example: 100Hz to 20kHz. This also implies that, for a system of 50 user stations, each user station would need to have an audio impedance of 50 times 200 ohms or 10,000 ohms. This, so, in the worst case, 50 user stations at 10 thousand ohms each, in parallel, would equal 200 ohms (10,000/50=200). The parallel impedance of the power supply (200 ohms) and the parallel impedance of 50 user stations (200 ohms) would make the system impedance 100 ohms, but the effect was minor (6dB). For call light signaling, 20kHz, and for system mic turn off 24 kHz were reserved.

6) All system power supplies would have short circuit protection. The supply would be fully operational immediately upon removal of the short circuit. The system power supplies would also have overvoltage protection such that a transient caused by the sudden removal of the load would be suppressed within 2 milliseconds (two thousandths of a second). The system power supplies would also have the capability of being shorted or overloaded forever without damage, then recover immediately upon removal of the short. The power supplies would have reverse voltage protection, and other protective elements.

Taking the Concepts to the Real World

1) The power supplies' no load standard DC voltage was 32 +1, -2 volts, and has been updated to 30 volts. Practically speaking operating distances are 500ft to 1000ft. Some special cases arise and are taken care of with some further tricks. Feedback from the field suggest 500 feet as a safe operating distance with 24 gage cable and a bit longer with 22 gage.

2) All future designs would be compatible with the first released system.

3) Each station (also called user station) would have the following features:

A) An audio impedance of 10,000 ohms. This requires a current source line driver, and a "rubber band" (explained later) power supply.

B) A microphone switch, which in its OFF position would suppress putting noise on the intercom line.

C) A channel selector switch on 2 and 3 channel stations.

D) A volume control on the station and not on the headset. This is to prevent clipping distortion.

E) A female XLR-4, XLR-5, or XLR-6 headset connector. Special stations may have different connectors. The pin out of the XLR-4 shall be Pin 1=Microphone ground, Pin2=Microphone high, Pin3=Headphone ground, Pin4 Headphone high. The pin out of an XLR-5 shall be Pin 1=Microphone ground, Pin2=Microphone high, Pin3=Headphone ground, Pin4=Left Headphone High, Pin5=Right Headphone High. XLR-6 and XLR-7 are often custom wiring according to the product.

F) An XLR-3 style system line input connector (female) and loop through connector (male). On these connectors The pin out shall be pin 1= system ground, pin2=, Channel 1, pin3=Channel 2. The system intercom was designed with the connectors opposite to those of a microphone + amplifier setup to minimize plugging a microphone into DC power.

(Continues)

Taking the Concepts to the Real World (Continued)

G) A limiter on the microphone preamplifier such that the maximum voltage put on the line by one station would be 2 volts peak to peak; and two stations, talking simultaneously, would be 4 volts peak to peak. This is because: 1) The system power supplies can only tolerate a maximum of 5 volts peak to peak, and 2) The limiter is also a compressor, and the net result is a more consistent audio level and better communication.

H) Headset user stations would be usable with loud external sound pressure levels such as those found at sporting events, rock concerts, arena events, or, conversely, quiet sound pressure levels such as a sound stage. In a quiet situation the headset should have enough isolation and the volume control enough range so that the intercom sound doesn't leak into the actors' microphones.

I) Over voltage protection against the transients produced by the system power supply. This also includes a fuse in each belt pack/user station to take a malfunctioning station off-line so that the remaining stations can still communicate.

J) An optional Call Light system multiplexed onto the same two wire pair. Each station would have both receive and transmit functions. Much later the Call Light became standard.

K) Non-master stations would operate, as a standard, on unbalanced lines. But an optional feature would allow balanced operation (usually requiring a "local" power supply.

L) Since 1990 an additional user station feature is a remote user station microphone shutoff. In 1996 the remoted shutoff transmit is part of the Model 803 Master Station.

M) In the case of the following power supplies: PS30, PS31, PS50, PS60, the output male XLR-4 pin out will be: Pin 1 = Channel 1, Pin 2 = Channel 2, Pin 3 = Channel 3, Pin 4 = Common. But the output XLR-3 male connector will be Pin 1 = Common, Pin 2 = Channel 1, Pin 3 = Channel 2.

Following, on the next page, are two diagrams to illustrate, first the *system* concept and second, the *user station* concept.

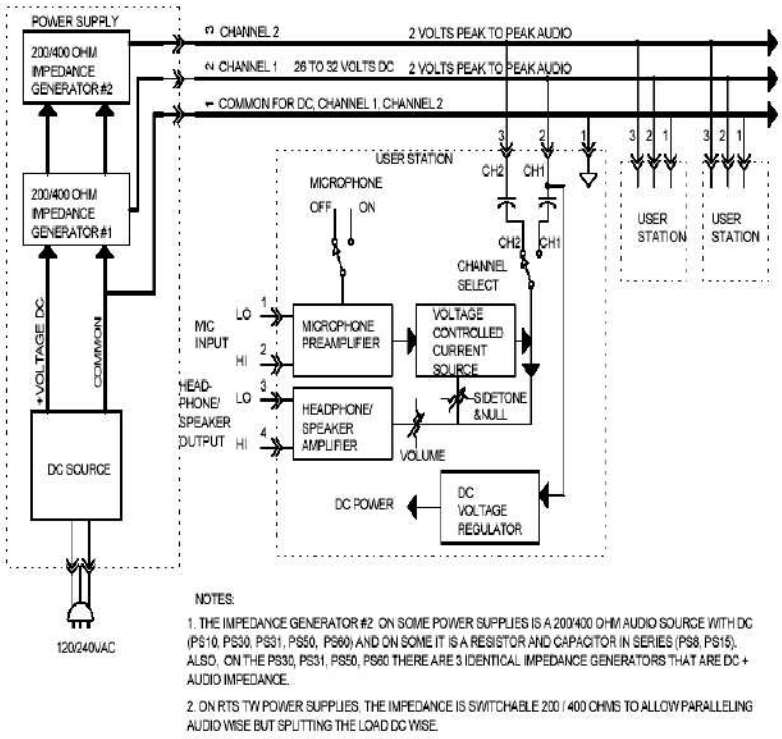

POWER SUPPLY
200/400 OHM IMPEDANCE GENERATOR #2
200/400 OHM IMPEDANCE GENERATOR #1
+VOLTAGE DC
COMMON
DC SOURCE
120/240VAC
CHANNEL 2
2 VOLTS PEAK TO PEAK AUDIO
CHANNEL 1 26 TO 32 VOLTS DC 2 VOLTS PEAK TO PEAK AUDIO
COMMON FOR DC, CHANNEL 1, CHANNEL 2
USER STATION
MICROPHONE
OFF ON
CH2 CH1
CHANNEL SELECT
MIC INPUT LO HI
HEAD-PHONE/ SPEAKER OUTPUT LO HI
MICROPHONE PREAMPLIFIER
VOLTAGE CONTROLLED CURRENT SOURCE
HEADPHONE/ SPEAKER AMPLIFIER
SIDETONE & NULL
VOLUME
DC POWER
DC VOLTAGE REGULATOR
USER STATION
USER STATION
NOTES:
1. THE IMPEDANCE GENERATOR #2 ON SOME POWER SUPPLIES IS A 200/400 OHM AUDIO SOURCE WITH DC (PS10, PS30, PS31, PS50, PS60) AND ON SOME IT IS A RESISTOR AND CAPACITOR IN SERIES (PS8, PS15). ALSO, ON THE PS30, PS31, PS50, PS60 THERE ARE 3 IDENTICAL IMPEDANCE GENERATORS THAT ARE DC + AUDIO IMPEDANCE.
2. ON RTS TW POWER SUPPLIES, THE IMPEDANCE IS SWITCHABLE 200 / 400 OHMS TO ALLOW PARALLELING AUDIO WISE BUT SPLITTING THE LOAD DC WISE.

Figure 2-1, Simplified Schematic of a TW™ Intercom System

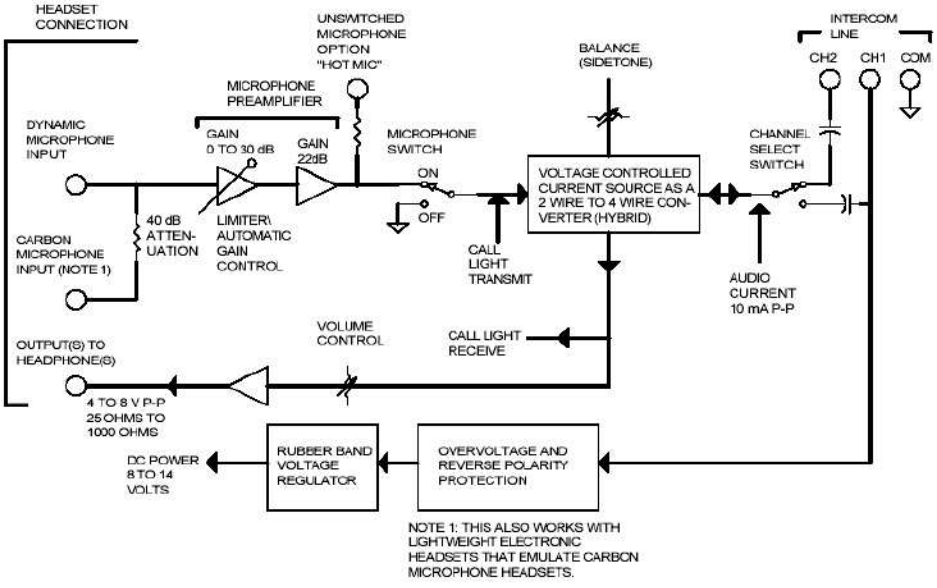

HEADSET CONNECTION
UNSWITCHED MICROPHONE OPTION "HOT MIC"
MICROPHONE PREAMPLIFIER
DYNAMIC MICROPHONE INPUT
GAIN 0 TO 30 dB
GAIN 22dB
MICROPHONE SWITCH
ON
OFF
BALANCE (SIDETONE)
INTERCOM LINE
CH2 CH1 COM
CHANNEL SELECT SWITCH
VOLTAGE CONTROLLED CURRENT SOURCE AS A 2 WIRE TO 4 WIRE CONVERTER (HYBRID)
CARBON MICROPHONE INPUT (NOTE 1)
40 dB ATTENUATION
LIMITER\ AUTOMATIC GAIN CONTROL
CALL LIGHT TRANSMIT
AUDIO CURRENT 10 mA P-P
VOLUME CONTROL
CALL LIGHT RECEIVE
OUTPUT(S) TO HEADPHONE(S)
4 TO 8 V P-P 25 OHMS TO 1000 OHMS
DC POWER 8 TO 14 VOLTS
RUBBER BAND VOLTAGE REGULATOR
OVERVOLTAGE AND REVERSE POLARITY PROTECTION
NOTE 1: THIS ALSO WORKS WITH LIGHTWEIGHT ELECTRONIC HEADSETS THAT EMULATE CARBON MICROPHONE HEADSETS.

Figure 2-2 Simplified Schematic of a TW™ User Station

Where It All Really began! The Garage in Pictures

Outside of the Garage-1970's

Inside of the Garage -1970's

Here are the shelves inside the garage, where we started, just above the assembly area. One of Doug's cats, Lola wanted to sit on an assembly position, so we made a parts box for her and she was content to stay in it. The picture is an oil painting by one our employees: Lisa Brown.

Some Early Employees 1976-80 Just Outside of the Garage

Left to Right: Dan Sternadel, Stan Hubler, Lisa Brown, Mike Berro, Inga Sabo

Fiona Campbell @ Lankershim Office

Ron Booth@ Lankershim Office

The Garage, Days and Nights

So when we started, Rick worked out of his apartment. Since I was still working full time, completing a project at the aerospace company, I worked on the intercom project during my lunch-hour, and at nights in Doug's garage. Doug's garage had no heating and no air conditioning. He rigged up some infrared lamps to keep us warm. My old Tektronix vacuum tube scope helped to heat the room, too. An anecdote: one cold night I was working with my ski parka on and several lamps pointed at me. I noticed an odd smell…alas! the lamp had melted my parka and a small camera in the pocket. But I was enjoying the work, and this was a small problem. Getting the strange new circuitry to behave was the big problem.

During the early part of this era, there was only Doug, Rick and I. Rick and I designed circuitry, Doug built it. Doug and I, both, evaluated its performance. Because of Doug's audio background, he had high standards, and it turned out that this was a very good thing. The future customers loved it; the company's reputation soared; RTS became a quality name. I was definitely for the high standards, but we also had schedules to meet. This caused some tension as the fine tuning of the system caused me to make running changes. And I was busy erasing and redrawing my hand drawn schematics.

At some point, Doug and his twin brother, Ron, overhauled the garage workbenches and made the garage more comfortable as a working environment. This helped when we hired our first employee, Inga. Doug had called an agency or placed an ad. Inga rang Doug's doorbell. Doug answered in his bathrobe. This disturbed Inga a bit, but when we showed her around the garage she felt better. It turned out that Inga had been laid off just the day before. She was an extremely good worker and a very well trained assembler. We were so lucky that her previous employer had laid her off. Inga stayed with the company 15 years until the company was moved to Minnesota. Fate smiled on us the day that Inga came to us.

As the company grew, the garage needed upgrading: a heater in the winter and an air conditioner in the summer.

Just before Compact Video bought us in 1979, we had five or six employees squeezed into that small space. And in addition to the employees, we had Doug's two Siamese cats in the garage. We were able to get one cat to sleep in a storage bin, which we labeled with the cat's name, Lola. The other cat, Lola's mom, often parked her self on the work in progress. We gently moved her out of the way.

Five of the employees were Mike Berro, Lisa Brown, Jeanie Hough, Inga Sabo, and Henri Sanchez. The girls assembled the belt packs, Henri assembled the PS50 power supplies and Mike tested and troubleshot everything.

The First Products Development

We decided the first products, a belt pack and two power supplies, would be developed in parallel. The belt pack was the first of many "User Stations". The power supplies were big and small: the bigger, the PS50, was to power 50 stations at once; the smaller, the PS10, was to power 10 stations at once. First, Doug and I developed the belt pack electronics. And Rick worked on the PS50, and I worked on the PS10. The belt pack connected the human being with the (party line) intercom system. It started with a headset consisting of a microphone and single or dual earphones plugged into the belt pack. The belt pack plugged into the intercom line. The belt pack received its power from the intercom line. Inside the belt pack the signal from the headset microphone was amplified and limited. The limiting took care of both the soft spoken and the screamers. Next, a headphone amplifier was developed. It had a volume control that made it able to supply a strong signal so that a camera operator could still hear the director during a rock concert or a football game. Yet the volume control could be adjusted to a low level so that a stage manager's headphone audio wouldn't leak into the actor's microphone. (The stage manager often stood close to the actor(s), but just out of sight of the cameras.)The belt pack had to be switchable to work on one of two channels (and later, both channels). The belt pack also had a switch to enable or disable the headset microphone. The party line concept allowed everybody to talk at once, but in reality, just the director spoke and everybody else listened. Of course if somebody asked a question, somebody else could turn on their microphone and answer. The belt pack also had the requirement to operate up to a half mile--(or sometimes further) away from the central power supply, located, say in the remote truck. The distance capability accommodated the belt pack's use in the athletic environment. The belt pack also had a "loop through" connector feature so that two or more people could share a single cable. A ¼" stereo jack is provided for those users that still had the old fashioned carbon microphone headsets.

Then the non-human features included cable miswiring protection, static suppression, radio station suppression, operation over the temperatures of -40 degrees Fahrenheit/Celsius to 120 degrees Fahrenheit(approximately 49 degrees, Celsius), that is, from the ski slopes to the desert. And the belt pack had to withstand rough handling such as being thrown into a large box at the end of the show. We actually tested the BP300 over the temperature range.

Another important feature, first optional then much later, standard, was the call light. When the crew was on break, the directing staff could signal everybody to put their headsets back on. Another feature protected the belt pack if a bunch of other belt packs were suddenly removed from the line. Also, the belt pack had to use readily available standard electronic components, be easy to assemble and repair, be reliable and be reasonably priced.

Another, feature, added years later, allowed all the microphone switches on the line to be remotely turned off. This was called by several names including "mic kill" (Pronounced "mike kill"). The mic kill receive function was standard on the future BP325 belt packs. The mic kill transmit function was standard on the future 803 master station (1996).

(Continues)

At the beginning, both channels had to have to DC power, but about 5 years later, a new design, a patented "Bilateral Current Source for a multi terminal intercom" got rid of that requirement, so that one channel with power, or an outside source was sufficient. This was incorporated in all the user stations from circa 1981 on.

Then We Developed the new Power Supplies

I developed the PS10 supply. The engineers at my day job said that it was impossible to build such a power supply but I made it work and it worked well just the same.

1. The requirements included a low noise, regulated 30 to 32 volt DC output. The PS10 supplied one ampere DC, which was enough to operate ten 0.1 ampere user stations. As it turned out, the first belt pack's peak current requirement was less than 0.1 amperes, so the PS10 could power more belt packs.

2. The power supply was also required to have an audio impedance of 200 ohms. Thus the belt pack could draw dc power from the power supply and yet talk and listen on the same wire and to all the stations connected to the power supply. This voice signal had an amplitude that ranged from 200 millivolts peak-to-peak to 2.0 volts peak-to-peak.

3. The power supply had to operate in ambient temperatures from -40 degrees Fahrenheit or Celsius to 120 degrees Fahrenheit (49 degrees, Celsius), for examples, a cold ski slope to a hot day at the desert.

4. The power supply has to withstand a short circuit indefinitely, yet, as soon as the short was removed the supply would be ready to operate.

5. Some power supplies were required to allow the selectable injection of "program" audio onto one of the two or three channels. Program audio is often the audio either broadcast or recorded.

Rick developed the PS50 power supply.

1. The PS50 supply was so named because it was supposed to be able to supply DC power to 50, 0.1 ampere user stations. It came close—it could power 40, 0.1 ampere stations. But in reality, the belt packs only drew less than 0.1 amperes, and speaker stations could draw more than 0.1 ampere so with an assortment of belt packs and speaker stations the system could run close to 50 stations. We could never get enough belt packs and speaker stations together to actually test this large of a system, because we had to ship these stations to our customers as fast as we could make them. But we tested the PS50 power supply with a heavy load and it worked just fine.

2. The PS50 power supply had 3 modules inside, one for each of 3 channels. The modules used a metal frame to help dissipate the heat that was developed. The PS50 was built in a 3 rack unit high package. Since Rick was busy at his workplace, Doug and I tested the first newly assembled modules of the first supply, one at a time. We applied power to the first module. A brilliant flash of light and a cloud of smoke resulted. We applied power to the

second and third modules: same thing. By this time the strong scent of burnt parts permeated the garage. Needless to say, this was a great disappointment, a very big oops!

At this time I had already finished the PS10 supply, so I tackled the PS50, finding out what went wrong. The problem was an overkill design, with too many parts. The extra parts caused the startup problems. So I got rid of about 2/3 of the parts and now the PS50 modules worked very well.

The result was a working 32 volt 4 ampere supply that didn't explode on turn-on. Its audio impedance was 200 ohms.

Fortunately, the PS10 was more docile, it used a totally different design from the PS50. It also used some "bullet-proof" parts (regulators) created by the geniuses at National Semiconductor in Silicon Valley. Both supplies had a raw DC supply followed by a 200 ohm impedance generator. The PS10 impedance generator was well behaved as well and each of the two channels supplied DC and had an audio impedance of 200 ohms. The PS10 concept was later used in the PS8, PS15, PS30, PS31, PS60 supplies.

More About Power Supplies

Purpose: Supply DC power to all the user stations (including belt packs) while maintaining a low DC resistance (1/2 ohm to 2 ohms) and an audio impedance of 200 ohms or 400 ohms. The audio impedance covers 100 hertz to 24 kilohertz.

The magic of making 1 ohm=400 ohms.
The ½ to 2 ohms resistance is the sense resistor for an amplifier which multiplies the error voltage seen across the sense resistor (400 times for a 1 ohm resistor). This is the principal behind the PS8, PS15, PS30, PS31, PS60. The PS10 is little trickier, but with a 200 ohm result: it uses a chain of emitter followers in the feedback loop. The PS50 is completely different…it uses the collector resistance of a power transistor to be the 200 ohm impedance. It works well enough to supply the ac impedance, but it is an inexact method.

Why 400 ohms?
When you have a very large system, and you need more DC power than one power supply can produce, you need two power supplies. Each power supply can supply enough power to run 30 belt packs or 10 speaker stations. To make this all work for the audio, you tie the two power supplies together audiowise but not DC powerwise, then reset the audio impedance from 200 ohms to 400 ohms. Now this big system has a combined impedance of 400 ohms divided by 2 or 200 ohms. So now you can have a system with the maximum of 50 stations.

The above example is an extreme situation. A more likely setup is: you have twelve channels and four 3 channel power supplies=12 channels. Then maybe 10 stations on each of the twelve channels. This situation means you need a dial-them-up Source Assign Panel (SAP1626) and a Break Out Panel (BOP220). But how do you talk to 12 channels of your crew? That's where a Master Station comes into play. And the Master Stations Model 802 and Model 803 are discussed below.

Now there is another problem to solve: the original power supplies have large transformers to change the 115 volts AC / 230 volts AC power to around 40 volts DC. The transformers radiate a strong 50 or 60 cycle field which would make hum on the intercom line which is an absolute no-no for quiet, clear communication. This hum would get into the intercom system via the sense resistors in each power supply, but we have another trick to solve that problem. The trick is to use two resistors for each sense circuit and parallel one backward to the other which cancels the hum out. Sometimes we used series connections and sometimes parallel connection, but it works either way. Some details: Sense power resistor(s) are all wirewound type resistors: PS8:1Ω 2W, PS15: two 1Ω resistors, connected in anti-series, PS30, PS31, PS60 two 2Ω resistors, connected in anti-parallel. The PS30, PS31 and PS60 have almost identical circuits. The PS30 and PS60 used the same circuit boards, To make a PS60 supply we loaded more parts and a transformer and changed the front and back panels with the same panels but with different silk screens. Marketing then decided to discontinue the PS60. The PS31 was a cost reduction redesign of the PS30. The redesign was not able to be modified to a PS60. The PS31 redesign was commanded by the accounting department to save money and it did, a little bit, but accounting was happy, and I was relieved. Because the PS30 and PS60 were discontinued, some customers sought existing PS30s to be able to convert to a PS60. By this time the PS50 had been long discontinued for a number of reasons: too costly, too heavy and too big. TV trucks have weight and space limitations. Ironically, nowadays we got rid of the hum a totally different way using "switching power supplies". This is in the Model PS20 and some future supplies. The hum would be at 200 kilohertz: way beyond human hearing.

About the PS10 series: (These were our very early power supplies).
There were three PS10 power supply models: The PS10 Lunchbox, The PS10 in a small case and the PS10RM. The PS10RM was a 2 rack unit high, rack mounted unit, intended to supply 10 user stations. The PS10 Lunchbox, came in an aluminum extrusion for portable operations. It had a handle on top so that it appeared to be a workman's lunch box. So it became the PS10 "lunch box" supply. There were no fans and the heat escaped via radiation from the extrusion on the PS10 Lunchbox. In the other versions of the PS10, the metal chassis served as a heat sink.

The PS10 and PS50 power supplies were our only power supplies until 1981 when we moved into our Chestnut Street Facility. Then we developed the PS30 and PS60. Then accounting decided that the PS30 and PS60 were not profitable enough, so they were discontinued after we had PS31 supplies coming off the line. Subsequently we developed PS8 and PS15 supplies. The PS30s in the field commanded a good price because people added the parts and made them PS60s.

An important accessory not yet discussed is a line splitter. A single 3-conductor line from a power supply could be expanded to five 3 conductor lines (all in parallel). The RTS model number of that box is TW5W Later a rental house (Bexel) created a one 3-conductor in, eleven 3-conductor out splitter box with an LED power indicator: Green: channel one powered, Red: channel two powered, Yellow: both channels powered.

The Mechanics of the early Belt Packs (and a near disaster)

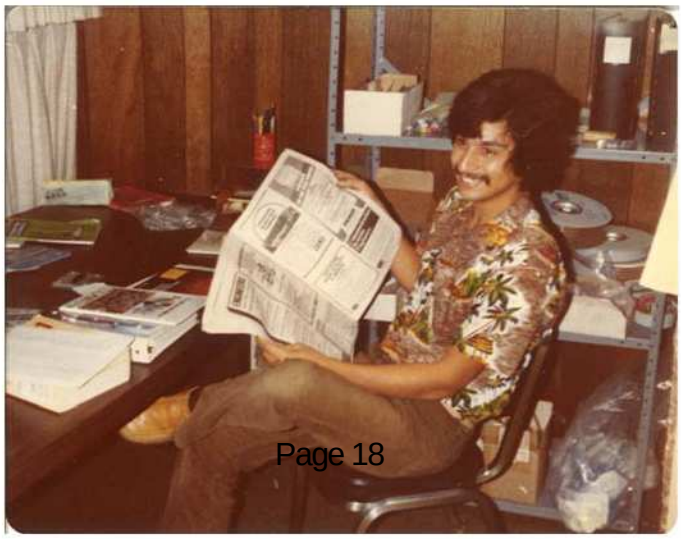
The first belt pack housings were made of a special aluminum extrusion. It came in long lengths and had to be cut off. The extrusion was made so that you could cut off two pieces of the same size and rotate one piece and they would fit together. We still needed to make end plates to hold the extrusions together. The two end plates were machined out of eighth inch thick aluminum. Four screws at each end held everything together. Our first belt packs were large compared with our production about a year later. During the following year we switched to a smaller fully enclosed extrusion and two end plates. A much nicer design. We were pleased with the results.

The Texas Trouble

But the timing of the transition to the new belt pack mechanical design caused us a major, unexpected customer problem. We had a bid on a large system for Texas A&M University (yep, those "Aggies"). Their system arrived with the new belt pack design. They liked the old design better even though it was bigger and heavier. Actually, we think that what they wanted was the perceived ease of maintenance of the split belt packs. They also demanded Teflon™ wire. (We didn't know why the Teflon™ was so important.) So the Texans made a big fuss, and rejected the entire system. This upset Doug so much he couldn't even talk to them. So it became my job to negotiate with the Texans. They talked real tough, threatening us with legal action from the state of Texas. Wow, we didn't want that! So I negotiated a settlement: We remade the belt packs by cutting the one-piece extrusions in two halves, adding some plastic gasketing (caterpillar strips), and changed the hookup wires to Teflon™. This whole escapade almost sank the company. We worked through it, shipped the system back and the Texans accepted it, and we breathed a great sigh of relief.

An additional note about Power Supplies. Sometime just before or after we moved to the Chestnut Street Facility we hired Charlie Neuman. Charlie, while going to school for his Bachelor of Engineering degree worked at an audio manufacturers facility. Later, for us, . Charlie created the PS30/PS60 power supplies, a very brilliant piece of work. Later, we derived from Charlie's work the PS31, PS5, PS15 supplies and I suspect the PS20 uses some of Charlie's design as well. At some point Charlie decided to move his family to Orange County and we lost a very brilliant engineer, but it was a good move for him since he got a well paying job in Orange County.

Charlie Neuman



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Our First Speaker Station

We started with an off the shelf speaker, added electronics & connectors, a push-to-talk microphone, channel switch, volume control, nulling pot (called here:sidetone) and we got a very loud & good sounding unit. Later speaker stations added a headset connection.

Our First Model Speaker Station

The present speaker station, the Model SPK300.

It takes a special circuit (#5) design to allow both a headset and a push-to-talk microphone to use the same connector. That circuit schematic is in the **Special Circuits Section**. The special circuit keeps the noise down. The hook for the microphone is on the right side. Note: A very nice SPK300-ASG appears on page 55, a modification by a rental house,

The old belt pack and a significant simplification

The belt pack user station was easier to design than the power supplies. But still, time consuming because we wanted it to be very good. Also, the usual constraints of space and cost prevailed. When we started, we didn't know about the new low noise audio op-amps chips. Maybe it was because they were only known in Europe or maybe they hadn't been invented yet. So we started out designing a very low noise microphone preamplifier with discrete transistors. This stage was followed by a 748 operational amplifier. This combination was quieter than even the present day designs with the low noise audio op-amps chip. But using the op-amp chips were a significant simplification and the system still worked well. At first we had trouble deciding how to turn the microphone on and off. Various schemes were built and tried. The object was complete shut off without any turn-on turn-off noises. It just required adding a capacitor. Finally we agreed on a first generation design. The schematic was sent off to make a printed circuit (PC) board. We put the parts in and it worked! The next generation belt packs had different circuitry and didn't have a noisy mic switch. This circuit drove the intercom line with a 10,000 ohm source impedance and received a signal from the line loading the line with that same 10,000 ohm impedance. This satisfied the original concept of allowing up to 50 belt packs or user stations to share the same line with only a six dB change in level, a minor change; six dB change is the same as when someone picks up an extension phone in a three person call.

The Engineering Move Out of the Garage (The Lankershim Office) **See also page 12.**
At one point during the garage days, there was not enough room for engineering documents, our two engineering employees: (Fiona Campbell, schematic drafts person and Ron Booth, enclosure and printed circuit board designer) and their drawing boards and myself. So I rented a large room in a business building in North Hollywood, about 2 miles away from the garage. It was upstairs, quiet and very pleasant. We even could play music at a low level to help us block some street noise and the music lowered our stress levels.

In the period between 1979 and 1980 the company was acquired by Compact Video. Part of the deal was a large building for us to move into. First the building had to be renovated. In the meantime, before we could move in, KNBC, channel 4 television in Los Angeles, placed a large custom order with us and we had to rent yet another room in the engineering building to produce the KNBC equipment. The equipment was to be installed into a "News Truck". The equipment required all new designs. The intercom was to be four-wire not two wire, and included IFB (Interruptible FeedBack). It also had a small two-wire system that was interfaced to the four-wire system. As I recall there were three or four four-wire stations. There were also power supplies, interconnection panels, headsets, and belt packs. The equipment had to be delivered very quickly and we had to work hard to meet the schedule. The equipment was designed, built and tested in the extra rented room in the engineering building. Our expanded product line was just coming into being. Our professional modular IFB system (Series 4000) was about four or five months away. We had a two wire master station (Model 801), but our 4-wire capable master station (Model 802) was about a year or so in the future. The equipment was finished, tested and installed in the "News Truck".

The Company Move to 1100 West Chestnut Street, Burbank
and We Became a "Real" Company

At last the building that was to be our home for the next ten years was complete. It was now time to move in. Engineering and production were both now in the same building. This building was air conditioned, a major help for everybody. Offices: The President, Douglas Leighton had his own office, with a window yet! I had my own office. The head of production had his own office. Marketing/Sales had two more offices. Marketing/Sales also had a brochure assembly room.

Production was greatly expanded. They now had their own parts storeroom, shipping and receiving, purchasing, production floor, test department, rest rooms, production office. Engineering was greatly expanded as well: a drafting room, engineering office, computer room. Eventually, Compact Video accounting moved out of that building into another new building. At that time, engineering moved upstairs. We now had room for production engineering, user Manual production, engineer offices and a large copy machine.

Fiona Campbell, our schematic drawing drafter and Ron Booth the mechanical engineer and printed circuit layout person were joined by Muriel Van Auken, our drafting room coordinator, part number assigner and drawing release person. As the company expanded, we were able to add two more drafting employees in the drafting room.

The new building had an inadequate phone system which we had updated to a Centrex system. The system was good but we needed more, an intercom and paging system, which we obtained. What a blessing! Before we transferred a call, we could call ahead and make sure somebody was there. Also we could page to find the person.

Another addition was a new general purpose computer, software included. The software included a word processor, a database, and, I think, a spreadsheet. It was a DOS system (disc operating system) with 8 inch floppy discs). I used it to print out the backlog, to write technical manuals, to keep track of our drawings and drawing numbers, and to write memos. Compact Video used it to do their annual report. Doug used it for memos and marketing information. We paid $15,000 for the computer and the software that came with it.

Engineering also acquired a small room for the engineering laboratory where we could test prototypes and breadboards. This room also made a place for our two new electronic technicians to work: Dan and Damon Register.

The whole building was air-conditioned by a 1940s style air conditioner compressor. It had apparently been in service for at least 35 years working day after day. After we had been in the building for a couple of years, the compressor had enough and it quit. A service company quickly repaired it and it was good for another 35 years!

Continues

The Move to Chestnut Street, Burbank and We Became a "Real" Company (Continued)

As Director of Engineering, I manned the engineering office which was just off the drafting room. I was also vice president and I gave tours of the facility for customers and guests. As Director of Engineering, I shopped for our first computer which was preloaded with software: a Database, Word Processor, Spreadsheet and two printer drivers. I also designed new products, wrote the User Manuals, kept the backorder log, developed the part numbering system, wrote engineering department directives and memos, worked with my engineers on their new designs, worked with the test department, wrote the Test Procedures, took out my staff for lunch periodically, kept my secretary busy, did service calls, wrote and delivered papers, attended managers meetings and answered questions from inside the company and also customer questions.

The company leased vehicles for our president, vice president, and shipping department. The shipping department had a small pick up truck to run errands. The Presidents and vice-presidents car were used to take prospective customers and visitors out to lunch.

We also had a kitchen and lunch room. To keep up morale we occasionally had pot luck lunches, where employees also got to know each other better. We had a wonderful crew.

Compact Video hired two cost accountants who visited us once a month, to count the parts, I think. I don't recall seeing them doing anything. When they came, the storeroom had to be shut down which was a problem for production and engineering to get parts to carry on the work. I thought two cost accountants was a bit much, and effectively shutting down production was far more costly than then any losses in the inexpensive parts. For example, we bought resistors in the thousands at a fraction of a penny each. Over the period of a year, maybe we lost a dollar's worth of resistors—far less than what we paid for two cost accounts for a days worth of work,12 months of the year. One cost accounting day, one of the accountants became angered about some storeroom problem and kicked a box on the floor which flew up and hit the other accountant purportedly in the head. But it didn't knock any more sense into either accountant's head.

As the years went by we bought more computers and engineering moved from hand making printed circuit board layouts to making layouts on the computer. We also put all the parts lists on the computer as well. And we published a User Manual for almost every product. With the later development of a new belt pack, BP325, electronic assembly was mostly robotic. Mechanical assembly and testing was still done by hand.

User Station Phase 3 & 4 Designs

Phase 3, The BP300, with a patented bilateral current source (Special Circuit #2)
Along about 1980 we introduced the BP300 with the bilateral current source. The bilateral current source made for noiseless channel switching, and it made it possible for the User Stations to be locally powered and the communication over a wire without DC. The patent expired at the beginning of the 21st century. The bilateral current source was incorporated in all the user stations. The trouble with the first two generations (phases) of belt pack user stations and user stations was that they required DC on every channel. And the DC made an unwanted click when the channel selection switch was operated. Phase 3 allowed the belt packs user stations to get their DC on channel one and on channel two DC power was optional. When a channel had no DC power on it, it was called "dry operation". If a channel had DC power, it was called "wet operation". Another feature of phase 3 was clickless channel switching. The current source drove the line with an impedance of 10k ohms. This satisfied the original plan of allowing 50 belt pack user stations or other user stations to share the same line with only a six dB change in level easily compensated with the volume control. The first Phase 3 belt packs were called BP300 or, with a call light, BP300L. Along with the BP300, new power supplies were designed and sold: The PS30 and the PS60.

Yet Another New Design, Call It Phase 4

About 1990, Doug Leighton and one of our engineers, Ed Fritz, designed the BP325. This belt pack user station had many microcontroller based operational and set-up features. It was also the first surface mount technology product for the RTS TW system. It had its own ruggedized, plastic case, which was our first journey into highly customized cases. This case made the BP325 a very good looking product. An advantage of this case over the BP300 cases was the non-conducting plastic. This prevented hum and noise on the intercom system when the belt pack user station was taped to something metal at the venue where it was used. The microcontroller allowed push button channel selection and microphone enabling. The push buttons had the same action as our Model 802 Master Station: a quick push meant alternate action, a sustained push meant momentary operation. Each of the two buttons had an indicator lamp associated with it. The lamp showed when the button was engaged and indicated when the microphone was enabled. Associated with each button was a volume control for that channel. The plastic case saved an enormous amount of case cost (no machining). I estimate that there are thousands of BP325s in service in the field. Of course there are also a very large number of the BP300s in use in the field. The case of the BP325 was tested by tossing it against a brick wall. In the prototype, the back came off. That was fixed so that production units were very rugged. This new belt pack user station still used the patented "Bilateral Current Source for a Multi-terminal Intercom". The BP325 user station is a standard even today (2013) and thousands of them have been sold. The BP325 microphone switch was able to be switched to the off position by remote control (a 24 kilohertz signal on the intercom line). The magic of the BP325 came with the software written by Al Salci, another one of our brilliant engineer/programmers. Another note: Since 1980 or so, the RTS user stations, power supplies, and headsets have been rented by a number of worldwide companies. Rental items take a huge amount of abuse. The RTS rental equipment has remained useful for many years. (Continues)

Even today, BP300s and BP325s are seen in the field that have obvious wear and tear and they were our early units, which means these products have paid for themselves over and over. A really great ROI (Return On Investment), indeed.

The New Power Supplies

The acquisition and the new building allowed me to hire an electronic engineer, Charlie Neuman and electronic technicians, Dan and Damon Register. With the additional help, we turned out more new products. In addition to the above, I was able to hire from the production floor, Lisa Brown, a college graduate, as the production engineer. With the additional space and personnel we created two new power supplies, the PS30 and PS60, very excellent designs by Charlie Neuman.

When we moved into the new building, we had more engineering personnel, and we could design new, aesthetic, and better power supplies, the PS30, PS31and PS60 with more features and more ruggedness. The power supplies were essential elements in the profitable systems we sold. This was the idea that went with the companies name "RTS Systems". The system power supply is the "heart" of the system. A lot of work went into making all of them as reliable and as "bullet proof" as possible, and components of the systems that we built. With the PS15, PS30, PS31, PS60 supplies, we added a 400/200 ohm impedance switch on the supplies. This switch allowed double the amount of user stations in a system by using two power supply where each power supply supplied DC to half of the user stations in the system but the two supplies were joined with capacitors to couple the audio in both supplies and the switches were set to 400 ohms so that the resulting line impedance was still 200 ohms.

The PS30, PS31, PS60 power supplies had a short circuit indicator lamp on the front panel and a beeper alarm. The beeper alarm could be shut off, for use in quiet environments.

They also had program audio injection, The audio was selectable to be on one of the three channels, and a level control set the audio level on the intercom line.

With a two channel beltpack (BP325, for example) the level may be set on the intercom channel 1 and the program level could be set on channel 2. The BP325 can be set to either monaural or stereo operation. For stereo operation, you need a stereo headset with a 5 pin XLR male connector.

How do you make a one ohm resistor look like a 200 ohm resistor? If you apply 1 volt across a 200 ohm resistor then the current would equal 1/200 ampere or 5 milliamperes. So applying 1 volt to one side of a 1 ohm resistor and elevating the other end of the resistor so that just 5 milliamperes would flow so then the resistor would look like 200 ohms. To do that we use an operational amplifier to apply a voltage at the end of the resistor so only 5 milliamperes flowed. That voltage would be 0.995 volts. Using ohms law:
(1.000V-0.995V)/1 ohm= 0.005V/1 ohm =0.005 amperes or 5 milliamperes,
so the voltage would be 0.005V/1 ohm= - 0.005V/1ohm=-0.005 amperes or 5 milliamperes.
When the voltage swings the opposite way:
(**-**1.000V+0995V)/1ohm= **-**0.005V/1 ohm=**-**0.005 amperes or **-**5 milliamperes.

Now a brief discussion of the Model 801, the predecessor of the Model 802.

The Model 801 Master Station (Created about 1979)

Created during the garage days, the Model 801 was created for Compact Video's new truck. This station could talk and listen to 1 to 6 channels simultaneously without connecting one channel to the other. It also could "squawk" four different locations. Squawk here meant one way communications to a another speaker system. This station had listen loudness controls for the six channels, and hidden inside each control was another null control which allowed trimming the channels so the master station channels had no undesirable feedback. The station also had a Speaker Mute button so that the director could have a conversation with someone in the room. The station was self powered. Each button had a light in it that would brighten when the button was engaged. The pushbuttons were an American made product that wasn't up to RTS quality. But the station was still usable, but very primitive compared to later products.

The Model 801 had self contained power supplies fastened on the rear panel. These supplies were a compact design, but probably not the latest.

Compact Video's 801 front panels were anodized brown to match the color scheme of Compact Video's video production trailer (By order of Compact Video's President, Robert Seidenglanz. Later production units were painted a light shade of grey. The Model 801 Master Station was used by Compact Video and others, but it was lacking some of the features that many customers wanted, and that led us to a completely redesigned Master Station with many new features: the Model 802 (in 1982).

I drew the Model 801 schematic overnight, about 15 hours. Contrast that with the Model 802 3 weeks and the Model 803 3 months.

Master Station Model 801

Master Stations Comparison, Model 802 (1982) and Model 803 (1996)

The Model 802 Master Station was to be our first computerized product. It also had higher quality lighted push buttons.

The Model 802 Master Station (Created after we had moved to the new building.) This was a "smart" station in that it had a microcontroller (microcomputer) in it.
The 802 Master Station had many features (some optional):

1) The buttons are mechanically momentary buttons, but, in the intercom mode, the connection is momentary if you hold down the button for over one second; but if you tap the button, the connection is alternate action. But a latch button can be programmed to be momentary only.

2) This time it had up to twelve channels. I say up to because the twelve buttons on the right can be reassigned to different functions.

3) It has four "Preset" buttons that can be programmed to bring up the other buttons or any group of buttons.

4) It has a built in chime with three different selectable sounds.

5) The talk button can be programmed to also turn on a listen button. Or the talk button can be programmed to turn off a listen button.

6) Six different relays can be programmed to be activated when a button is pushed.

7) This station can send and receive call light signals.

8) The Adjustment Board. Pushing the slide out unlatches it and it can be then pulled out. The Adjustment Board contains: A) Listen level controls, B) Assignment switches, C) Programming command switches, D) Balance (null) controls, E1) Lamp brightness adjustment, E2) Speaker Dim Adjust, E3) Sidetone level, E4) Chime level, E5) Squawk Level, E6) Panel MIC gain, E7, Headset MIC gain, F) Reset button, G) Status lamps.

9) The IFB option. The right hand 6 buttons (3 above and 3 below) can emulate an IFB Model 4001. In the Model 4001 case, The right hand top 3 buttons and the right hand bottom buttons are used as follows: top buttons 10,11,12 are IFB 1,2,All. The right hand bottom buttons 10,12,13 are IFB3, IFB4 and SA1. The right hand twelve buttons can emulate an IFB Model 4001 and Model 4002. In the last case, top row buttons 7 through12 are IFB 1-4, SA1, SA2. The bottom row buttons 7-12 are IFB 5-8, IFB All.

Continues

The rear panel of a fully optioned unit:

1. RS232 Connector, 9 pin. 2. Line Connector (25 pair). 3. Ancillary Connector (25 pair) 4. IFB option (25 pair). 5. Squawk option (25 pair). 6. 4-wire option (25 pair). 7. ISO option (25 pair). 8. Relay terminals, six 3-pin Phoenix connectors. 9. Mic switch external contact. One 2-pin Phoenix connector.
10. External VCP connector, 5-pin Phoenix connector. 11.External Headset, 5-pin Phoenix. 12. External MIC connector, 5-pin Phoenix. 13. External Program Contacts, 6-pin Phoenix. 14. Two "hot" Mic outputs each with Mic/Line level switches, and each with Switched/Un-switched switches, each with 3-pin Phoenix connectors. 15. External Speaker with on/off switch, 2-pin Phoenix connector. 16. Power Supply Input, 3-pin Phoenix connector.
Note that in case of both IFB 4001, and IFB 4002 emulate, Connectors 5,6,7 may be needed to install IFB 4002 if the connectors are not otherwise used for Squawk, 4-wire, or ISO. The Model 802 has two "hot Mic" line level outputs.

The Model 802 software was written by Walter White, a professional engineer. The software and hardware were designed together with the following feature: whatever the setup was during a given shoot, it was preserved during power down with the aid of a battery. The battery was charged when power was available. In the event that the battery was not charged enough or just not working, the setup was not held overnight during power down, but the Model 802 still worked and it would keep a new setup as long as there was power.

The Model 802 software has many user friendly features, which are explained in the Model 802 Operation Manual. Its also possible to adjust the 802 program using a RS232 port.

After the Model 802 Master Station starting selling in 1982, it became a standard nationwide and even world wide.
The Model 802 Master Station Power Supply (Model 56-16)
Input: (Switch selectable) Fuse must be changed according to power source.
115VAC±10% ½ amperes
230VAC± 10% ¼ amperes
Fuse @ 115VAC 3/4 ampere, Slow Blow
@ 230VAC 3/8 ampere, Slow Blow
Output: 16VAC @ 3 to 4 amperes.
Front Panel Green LED Will light when16VAC power is available.

Power Supply Connections: 16VAC to Master Station: TB-1 Black 16VAC

TB-2 White 16VAC TB-3 Green (Earth Ground)

Place the 56-16 power supply at least 1 foot to 2 feet from the Model 802

Front Panel Replacement Lamps: #7382 Mfrs. CML, JKL, VCC, 14V, 80mA, BI-PIN, T1 ¾

Features Common to Both Model 802 and Model 803

Presets Total Mute Relays Chime Select Latch Disable Auto Listen

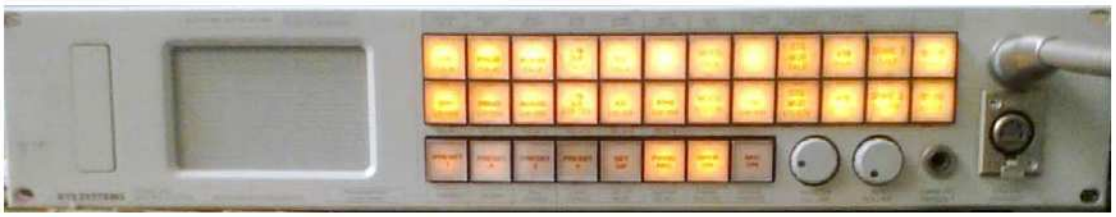
Preset Exclude Auto Talk Special Purpose External Contact Button Lock

Talk Turn On Listen Instant Mic Talk Turns Off Listen Bilat Select

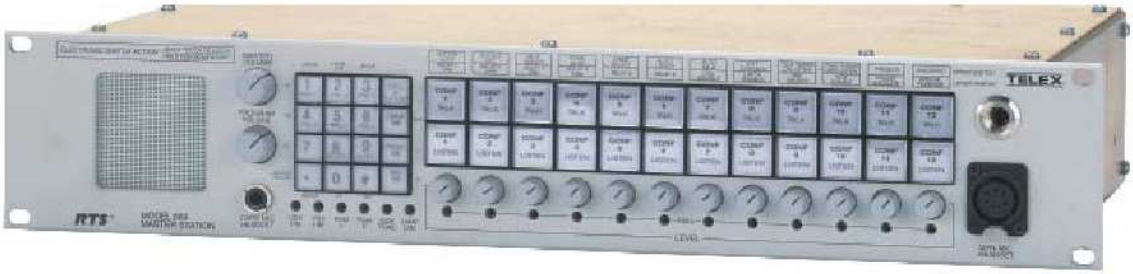
The Model 802 Master Station, (1982) became an industry standard for about 14 years. It was replaced by the Model 803 (1996). But then the digital matrix system became the standard and the Model 803 took on another role as a monitor at the Red Carpet pre-awards ceremonies where a number of television stations trucks and uplink trucks all had separate RTS 2 wire systems and a crew from a rental company monitored all the different trucks for calls for maintenance. The Model 803 was used in at major sporting events such as the Superbowl to monitor all the trucks.

Listed below is a comparison chart between the Model 802 and the Model 803.

Model 802 Master Station



Model 803 Master Station



Models 802 and 803 Master Stations

Comparison of Model 803 and Model 802 Master Stations

Parameter	Model 803	Model 802
Depth	10 inches (25.4 centimeters)	14.25 inches (36.20 centimeters)
Weight	10 pounds (3.73 kilograms)	18 pounds (6.70 kilograms)
Standard Channels	12 Channels	6 Channels
Internal Jumpers	2	Many
Technology	Surface Mount, & some thru hole.	Through Hole
Indicators	LED	Incandescent lamp
Hot Mic Output(s)	(1) Adjustable to +26dBm	(2) Fixed at 0 dBm
Outputs	Active Balanced	Transformer Balanced
Listen Controls	Front Panel	Adjustment Board
Null Adjustment	Front Panel	Adjustment Board
Lamp Dim Adjustment	Front Panel	Adjustment Board
VOX Adjust (Mic triggered by voice)	Front Panel	Not Applicable
Local IFB	Yes	Only with Model 862
Local IFB Program Adjustment	Front Panel	None
DTMF Generator	Yes	No
Talk Off Signaling	Yes	No
Call Light	Standard	Optional
2W/4W Select	Via Software	Via Hardware
Listen Output Configuration	Via Software	Via Hardware
Headset Connector	Optional 4-,5-,or 6 pin	Optional 4-,5-, or 6 pin Female
Auxiliary Connections	(2) DB25 connectors	Rear Panel Terminal Strip
Program lockout	Via Software	Via Hardware
CPU Watchdog	Yes	No
Circuit Cards	3	Up to 14
Listen Activity Indication	12 channels	None
Mic inputs and levels	Rear Panel adjustable, RV19, RV20	Fixed
Panel Mic	Removable	Non-Removable
Warm/Cold Start	Front Panel	Adjustment Board
Multi-listen Dim	Yes	No
Presets	6	4
Squawk Optionable	No	Yes

The IFB System

While we were still in the garage, and prior to being purchased by Compact Video, Doug sold an IFB system. He wanted to connect some old technology stuff, and I said why don't we use the technology we already developed? He thought for a moment and agreed that we should move ahead and develop the new IFB. And so the 4000 series IFB was born. The new system was a one way communication system. The new system worked very well, but the packaging was not optimum, so one of the first orders of business when we moved into the new building was to make a real IFB product. This IFB system was made modular so that customers could buy the size of system that fit their needs. The IFB system turned out to be a very popular product and sales were very brisk. The system is still in use and being sold today, along with new interfaces to the digital systems.

The first IFB systems had the central electronics in a card cage. We sold 2 ½ card cages of those systems before we moved into our new Chestnut Street location.

Overview

The IFB system allows the Producer, Director, Technical Director to talk to the Talent (actors, announcers, performers). Usually the Talent(s) are connected to a program audio source, and often they will hear themselves talking. When the Producer or a Director pressed a button on a nearby Control Panel the program audio is interrupted and the actors, et cetera will hear a Producer or a Director speaking. For on camera talent, Telex and others sells an in the ear plug connected via a transparent tube to a transducer hidden in the talent's clothing. Then there are two possibilities: 1) the earpiece plugs into an electronic box which is cabled to back to the system, or 2) the earpiece plugs into an electronic box which is wireless and dialed to a number assigned to that particular talent. When the Producer, Director, Technical Director is not prompting the Talent, the Talent may hear the program audio being broadcast, (program audio), and they also hear themselves talking. The idea is the talent can get cues when to talk or to answer another person in the system.

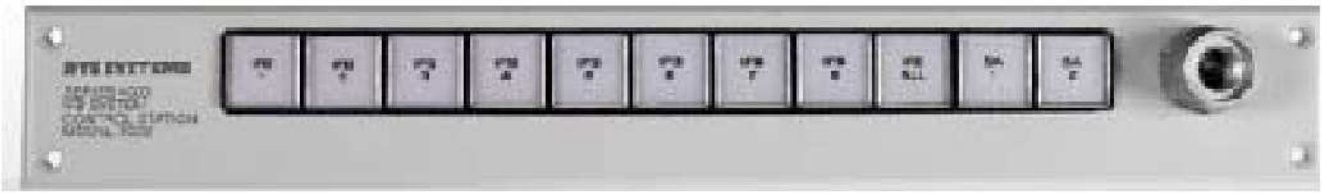
The New System

At the Chestnut facility, the new IFB system consisted of three different Control Panel products: 1) A four IFB Control Panel (Model 4001), 2) An eight IFB Control Panel (Model 4002) and 3) a twelve IFB Control Panel (Model 4003). A control panel combiner (Model 4025).allows the connection of multiple control panels. Each Control Panel had two extra buttons: an ALL button and an SA button. The SA button controls the Stage Announce loudspeaker system, used during rehearsals or off air times, for example during commercials. Four IFB Control Panels connect to a 1 by 4 combiner (Model 4025) which combines the Control Panel signals and passes the four Control Panel signals to the Central Electronics unit, Model 4010. The Models 4025 and 4010 still handle each Control Panel individually, so that the Priority feature is still available. In addition to the Control Panels, the system includes one Central Electronics (Model 4010) per four IFBs and a User Station (Model 4020 or Model 4030) for each IFB. The IFB Control Panels are programmable for priority. A higher priority allows a Control Station to override a lesser priority or prevents a lesser priority from interrupting a higher priority.

The Nuts and Bolts of the IFB System.

The 4001Control Panel, 4 IFBs, IFB ALL, SA (Stage Announce)

The 4002 Control Panel, 8 IFBs, IFB ALL, SA



The 4003 Control Panel, 12 IFBs, IFB All, SA1, SA2, SA3

The IFB 4010 Central Electronics

The IFB 4020 Talent User Station

The IFB 4030 Talent User Station

After Telex Moved RTS from Burbank, California to Minnesota (ca 1991)

The Model 802 was designed at RTS, Burbank in 1982. The Model 803 was designed at my company, Smartsciences, in Valencia CA in 1996. More Model 803 information next page. Telex bought RTS in 1989 and moved it all to Minnesota around 1991. I was offered a job in Minnesota, but my wife, Pamela, and I decided to stay in California, but I still did work for RTS/Telex as a consultant.

Eurodisney Project, an intercom for amusement park rides

Eurodisney Project: Circuit design (Schematics and Parts Lists) by Smartsciences in Santa Clarita, California; mechanical & printed circuit design by Ron Booth in North Hollywood, California; and Software design in Canada; manufactured by Telex, Minneapolis, Minnesota..

The Walt Disney company created a Disneyland park in France, it was called Eurodisney. They wanted a ride intercom quote before our move from Burbank; we tried to get the move postponed so we could take care of Disney, but that didn't happen. Shortly after the move from Burbank, Telex asked me to create the ride intercom for Eurodisney. Disney wanted an intercom at each ride location. At the time we created a ten location intercom. Each intercom station had a handset that hung up on a bracket, like a wall telephone, but had ten push-buttons. Each pushbutton would cause a particular station to beep and the person next to the station would answer. All the stations were wired to a shed where a computer in a metal enclosure would interpret a button push on a particular station and cause a particular called station to beep. The design had to meet European and French electrical/mechanical standards which were more strict than American standards. A feature of the stations is a magnetic hang-up detection feature-no mechanical switch to break.

The RTS SSA424 Project, an automatic two-wire to four-wire interface.

After Eurodisney, the next project was the automatic two wire to four wire interface, the Model SSA424. It was an automatic interface using a special chip originally for telephones. I sped up its digital clock so the response was closer to that of the two wire system. The interface worked, but there was an unplanned surprise: during normal operations, if there was acoustic feedback between two four wire stations, the SSA424 would re-null itself. This would annoy some people, so they would replace the SSA424 with the SSA324 which had to be manually nulled. But the null didn't change and that was better for some people. In the years since then I have designed a better automatic system that nulls and stays nulled. It takes just one button push and it's done.

The Box Office Intercom Update Project.

Yet another project for Telex was to update the "Box Office Intercom". This project was difficult because of the small case which was prone to feedback. It turned out the solution was to fill a hole in the interior of the case with epoxy glue. This was one of the non-scientific fixes we had to do occasionally. The cashier in the booth could use a gooseneck microphone or a headset. The customer outside would just listen and speak. The design fit in a little hole in the window. (Continues)

The Telex TIF2000 Telephone Interface.

Another project was an analog telephone to four wire converter. This was another urgent project because Telex had contracted with another company to rebrand that company's telephone interface product and the company was very slow in sending the units to Telex. This was an embarrassment to Telex. So they asked me to design a telephone interface to be made and sold by Telex. I designed the TIF2000 and it worked as specified. A side note to the TIF2000, I designed the unit to interface one phone to the digital matrix. It turned out Telex sold 24 of the TIF2000s to the Wall Street Journal to be combined into one matrix station. Telex flew me into Philadelphia then New York to witness the problem that the Wall Street Journal was having. I recognized the problem and returned home to implement a successful fix. We re-spun the layout (I added a limiter to the four wire input).

The Model 803 Master Station Project, 1996 **Software by Walter White**

Telex personnel and I met at the new Burbank sales office to agree on a schedule and a price for the Model 803. As usual, the price I bid was too low, but we managed to create the Model 803 anyhow. By this time I had rented an office in Valencia, California. It took about 3 months to draw the schematics and make the parts list for the Model 803, and a number of weeks for Ron Booth to lay out the circuit boards and design the enclosure. Then it took some weeks for Walter White to write the software. Walter had written the software for the Model 802, so Walter was able to turn out the software creation rather quickly. We had to hurry for the completion because of an upcoming NAB show (NAB=National Association of Broadcasters).

Walter White and the Model 803 Master Station

When I showed the Model 803 in Minnesota before the show the staff was impressed how clean the layout was, with two boards at the front panel and one large motherboard. Then I turned over about twenty pages of documentation to Telex's Engineering Department. I also sent the schematic in OrCad format to Telex's Engineering Department. I also wrote a draft of the User Manual.
I drew the schematics and made the parts list (BOM).

(Continues)

Ron Booth designed the enclosure and laid out the circuit boards.
The Model 802 has up to 14 circuit boards and over 25 interconnecting ribbon cables, and up to six rear panel cables (depending on options).
The Model 803 has just three circuit boards, no interconnecting cables, and up to six rear panel cables (depending on options).
The Model 802 uses through hole parts; the Model 803 is mostly surface mount parts.
The Model 802 has incandescent lamps in the switches. The Model 803 has LEDs in the switches. Both the incandescent lamps and the LEDs are plug in.
The individual listen gain, the master gain and the program gain pots on the Model 802 are all analog.

The individual listen gain, the master gain and the program gain pots on the Model 803 are all 16 position digital.
The null pots and other trim pots on both the Model 802 and Model 803 are analog pots.
The panel mic on the Model 802 is fastened to the front panel.
The panel mic on the Model 803 is easily removed (unscrewed) from the front panel. And the customer can easily choose three different size panel microphones, or no panel microphone (Headset Operation)
The Model 802 is optionable for ISO, IFB1, IFB2, 4 wire, and squawk operation.
The Model 803 is optionable for the same options as the Model 802 but no squawk option.
The Model 803 has call light available on all channels.
The Model 803 has the built-in system Mic Kill feature but the Model 802 does not.
The Model 803 has a 16 position security switch (Key Code) on the rear panel, to prevent unauthorized personnel from changing the Model 803 setup.
There were long drawn out discussions on how to add the options to the Model 803, how much to charge, how do customers order the options. Finally, marketing decided that the customers would install the options, which were in kit form, or order the options to be factory installed. Installation consisted of fastening a connector of the option assembly on the rear panel, then plug in the other end into the mother board. To activate the option, one had to tell the 803 computer via a pushbutton routine which was on a paper as part of the option. If the option was factory installed, a tag was put on the 803 top panel to indicate an option was installed. I thought that the Model 803 should be sold complete with details in the User Manual how to set the options up. It would save labor costs and speed up deliveries. It also showed that RTS was on the customers side to make field use flexible and easy to use.

The electronic design, schematics, parts list were done at my Valencia Office. The layout and enclosure designs were accomplished by Ron Booth at his location. The design phase took me about 3 months and Ron Booth's design was less than a month. The software by Walter White took less than a month. Walter was able to use some of the software from the Model 802 design. At some point near the end of the design phase and prototype construction, Telex set a deadline to have a working unit at the NAB show. Upon checking the design, I needed to have Ron Booth add some more electronics. As it turned out, we needed now to make up for the delay so we had the board made over the weekend. This cost $3000 for one board! But we made the deadline and Telex was delighted with the very clean design: three boards instead of fourteen in the 802!. Also, mostly surface mount parts were used. The Model 803 won an "Editors' Pick Of The Show" at the NAB show.

Professional Audio Products (No longer in production)

RTS also created another product line: Professional Audio Products.

These products are no longer manufactured, but often are available used, on Ebay and in rental houses. These products are high quality and many are still in service.

These products included:

1) **Model 1400**, A battery operated dynamic microphone amplifier with GAIN control, switchable LIMITER, switchable POWER, a female XLR3 connector to plug in a dynamic microphone, a male XLR-3 connector to connect back to the audio board (often in a truck) cable plus dynamic microphone, A male XLR3 connector to plug in a cable back to the audio board (often in a truck), and on some versions, 3 insulated pin connectors on the rear panel to check the batteries. The rear panel had a thumbscrew to allow changing the two 9 volt batteries. I happen to have two of these units that I used to test out various systems that I designed. It was designed before I came to RTS by some very talented audio engineers. I heard that this unit was used over long distances on golf courses.

2) **Model 416**, 1X6 Distribution Amplifier. The front panel had six adjustable level potentiometers and one master gain potentiometer. The rear panel had a balanced input connector and six balanced output connectors. The unit was stand-alone or rack mountable. The rear panel had a fuse and a power cord. The audio inputs and outputs were all transformer coupled.

3) **Model 424**, 1X4 Distribution Amplifier. The front panel had four adjustable level potentiometers and one master gain potentiometer. The rear panel had a balanced input connector and four balanced output connectors. The unit was stand-alone or rack mountable. The rear panel had a fuse and a power cord. The audio inputs and outputs were all transformer coupled.

4) **Model 444** Dual Two-Channel Buffer Amplifier. The front panel had two adjustable level setting pots and a power indicator. This amplifier was designed to interface professional balanced line level equipment with semi-pro high fidelity equipment. The Model 444 accepts a stereo pair of balanced input signals at a nominal level +4dBV. These signals are attenuated and isolated through active circuitry and converted to IHF standard nominal 0.5 volt unbalanced signals. The back panel had RCA connectors for IHF equipment and terminal strips for the professional balanced level equipment.

5) The **HPM-41** (Designed by Bill Eisenberg) This was a successful effort to make a much upgraded mixer over a Shure mixer, I think Shure M67. It was widely admired by audio professionals, but RTS Systems only sold it for a short time, maybe 1 or 2 years.
The **HPM-41** is a monaural mixer. It has four balanced inputs, each channel has a pot and a two position pad: 15dB or 30dB on each of the four channels. There is a master gain pot. Phantom power on channels 1 and 2 only: 12V A-B or 48V phantom power.

Professional Audio Products (Continued)
Model Series 2500 (No Longer in Production)

●The Model 2501 - A Card Frame 3 rack units high, room for 8 modules and 2 power supplies.

The Series 2500 offers space saving high-density packing for both large and small audio requirements. Up to 7 different circuit card types and 2 power supplies fit in 3 units of rack space. The standard 19" Card Frame assembly was designed to meet EIA standards and is built to stringent specifications to ensure mechanical integrity even in portable applications.

●Model 2510 is A 1X6 Audio Distribution Amplifier is high performance audio distribution amplifier with a single electronically balanced input and six amplifier/transformer balanced outputs. There is a master level control as well as individual controls for each output channel.

●Model 2512 is a Stereo 1X6 audio distribution amplifier is a high-performance audio distribution amplifier with two electronically balanced inputs and twelve resistively-split balanced outputs. It may be used as a single input, twelve output amplifier or a stereo 1X6 amplifier (two separate single input, six output amplifiers).

●Model 2514 Quad Line Amplifier is a high-performance audio line driver amplifier with four electronically-balanced input and four amplifier/transformer isolated balanced outputs. It may be used as a four input, four output group of individual amplifiers or a stereo pair of amplifier since electrical isolation between amplifiers is sufficient to eliminate any introduction of crosstalk.

●The Model 2516 Quad Buffer Amplifier is a four-channel audio buffer amplifier designed especially to interface professional "balanced, line level" equipment with various types of industrial, semi-pro and consumer high-fidelity equipment.

●The Model 2522 Universal Relay Card comprises ten individual DPDT relays with buffered logic inputs in a single circuit card module. Designed to be used with the Model 2501 Card Frame and Model 2505 Power Supply, the Model 2522 offers versatile relay switching in a simple, straightforward configuration.

●Model 2524 is a dual 8X1 audio summing amplifier with 16 actively balanced input and 2 actively balanced outputs. The first 8 inputs sum into the first output stage while the second 8 inputs sum into the second output stage.

●The Model 2528 Dual Microphone Preamplifier is designed to eliminate the problems caused by long cable runs at microphone level. To achieve this resolution, the 2528 is placed in a position close to the associated microphones. The 2529 amplifies the microphone signal and sends it to the mixing console at a high level.

●The Model 2005 Power Supply is especially designed to work in the 2501 Card Frame assembly. It is a dual output unregulated power supply with nominal output voltages ± 28 volts and a maximum output current of 2 amps. Specify 115 or 230 volts ac.

Matrix Systems (A Four Wire System)

Early on, RTS had designed a simple matrix system, the Model 848. It was installed in Toronto at the Sky-Dome stadium. The Model 848 was not a big seller as a matrix.

After Telex bought RTS Systems, they bought McCurdy's matrix intercom line. Some time after the move to Minnesota, Telex invented two new matrices: The Zeus system and the Adam system. RTS Telex sold the Zeus and Adam systems sometimes with a two wire TW™ interfaced to the matrix. The matrix is used in studios and television trucks. So in television trucks the configuration is matrix in the truck and two wire outside the truck. Telex already had a wireless intercom with wireless belt packs. Telex made further advances in internet technology. The net result is Telex has sold intercom systems worldwide, mostly with four wire matrices and wireless systems and sometimes the TW system. This had made Telex in the 21st century the primary supplier of intercoms, world wide. Besides the Zeus and Adam, there are also Cronus, RVON, and OMNEO.

KP-32 Keypanel

More pictures, next page

The RTS ADAM 64 Channel Advanced Digital Audio Matrix Intercom

RTS Zeus 24-Channel Digital Audio Matrix Intercom Mainframe

Special Circuits Section

The following 6 pages have significant circuits and explanations.

Circuit 1: Limiter/Compression Circuit: Levels out speaker voices and keeps the output to the line below 3 volts peak to peak.

Circuit 2:*Bilateral Current Source: Converts a voltage signal to a high impedance current signal, reflects a 10,000 ohm load to the 200 ohm intercom line.

Circuit 3: Rubber Band Regulator: Prevents crosstalk from channel 2 to channel 1.

Circuit 4: PS8, PS15, PS30, PS31, PS60, PS20 Regulator: Converts one ohm audio impedance to 200 or 400 ohms audio impedance.

Circuit 5: Speaker Station: Push-To-Talk phantom circuit: Makes a headset connector a combination microphone input and a push to talk circuit. Also prevents unwanted circuit noise.

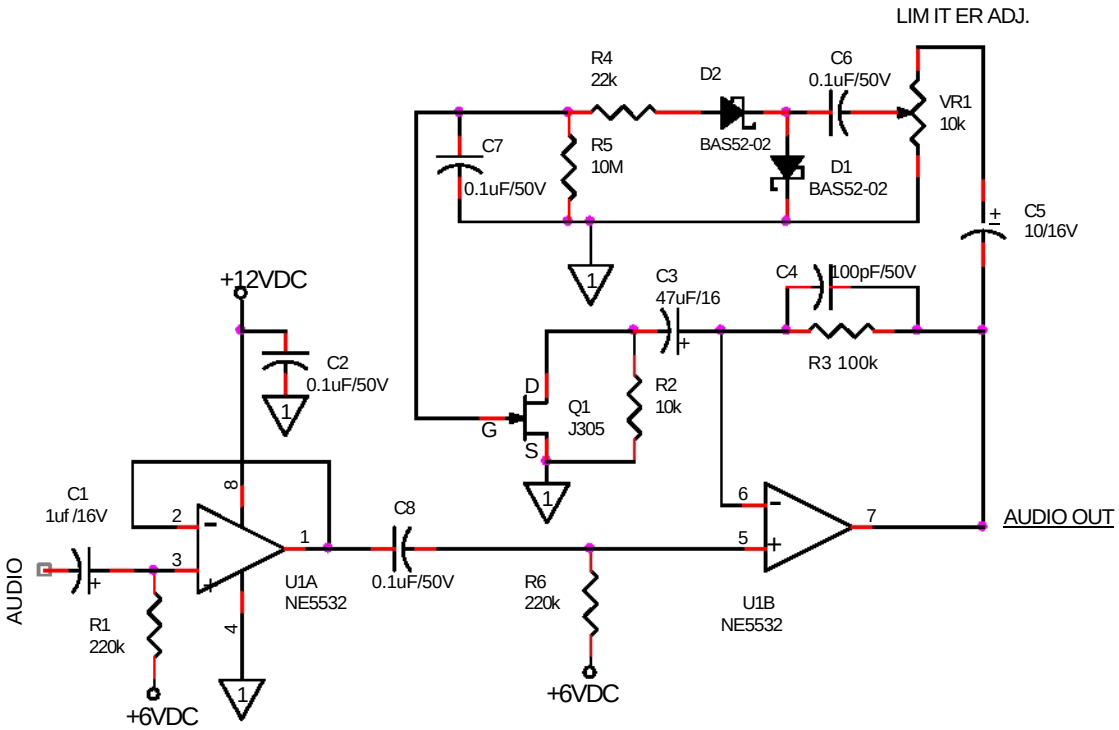
Circuit 6: IFB DC plus Audio driver supplies DC and audio to the 4020 IFB receiver.

*One of the circuits, the "Bipolar Current Source For a Multi-Terminal Intercom" has been used in all the two wire belt packs and user stations since 1979. This circuit has the capability of sending a current but receiving a voltage from the intercom line. The patent on this circuit expired in the early 2000s, but is still used in RTS user stations, including the belt packs, of course.

Circuit 1: Limiter/Compression Circuit

This circuit brings down loud voices and brings up soft voices.

Audio is applied at AUDIO IN then passes through C1 and is buffered with no gain through U1A. The signal then passes through C8 to U1B, and appears at U1B, pin7. The signal appears at the right side of R3, the feedback resistor, and C5. The signal passes through C5 to VR1. The reduced signal appears at the wiper of VR1 and at C6. Diodes D1 and D2 level shift the signal so that it is only negative going DC type level. The negative DC passes through R4 and is filtered by C7 to a slowly moving negative DC voltage. Q1 is a depletion type FET such that the more negative voltage applied to the gate makes the drain to source resistance higher. A resistance at Q1 of, say 100k ohms means U1B gain is determined by R3 and R2 and, in this case will be 10+1=11. This, then, is the minimum gain. If Q1's minimum resistance is 1k ohm, the gain at U1B then will be 101. So the limiter circuit has a range of [20log(101)=40dB - 20log(11)=20.8dB]. Thus the circuit has a maximum compression of about 20dB (1/4 as loud to a human ear). VR1, in conjunction with D1 and D2 can adjust the threshold of the limiting/compression action. The schottky diodes have a threshold of about 0.35volts. C3 keeps the +6VDC off of Q1 and R2. C8 is a coupling capacitor. C4 rolls of the gain above audio frequencies so U2B won't oscillate. The attack time constant is about 2.2 milliseconds for one time constant. The decay time for one time constant is 1 second. The idea is to prevent a transient signal from causing signal clipping. The maximum signal at the AUDIO OUT terminal is about 10 volts peak to peak without the limiter. The desired signal is 3 volts peak to peak maximum, which produces 2 volts peak to peak on the intercom line after passing through the bilateral current source stage.



Circuit 2: Bilateral current source for a multi-terminal intercom
This circuit shows 10k ohm to the intercom line, but delivers a level signal into the line. This drawing is to illustrate a bilateral current source and the recovery of audio on the intercom line. Audio at U1-2 appears at U1-15 when the MIC SW is set to the ON position. Audio then enters U2-3 and comes out at U2-1 unchanged, then through C3 to R3 and to VR1. The signal passes through U2B and is inverted and applied to the other side of VR1. VR1 is adjusted for a null while talking or making a noise from this station. Bilateral current source for a multi-terminal intercom

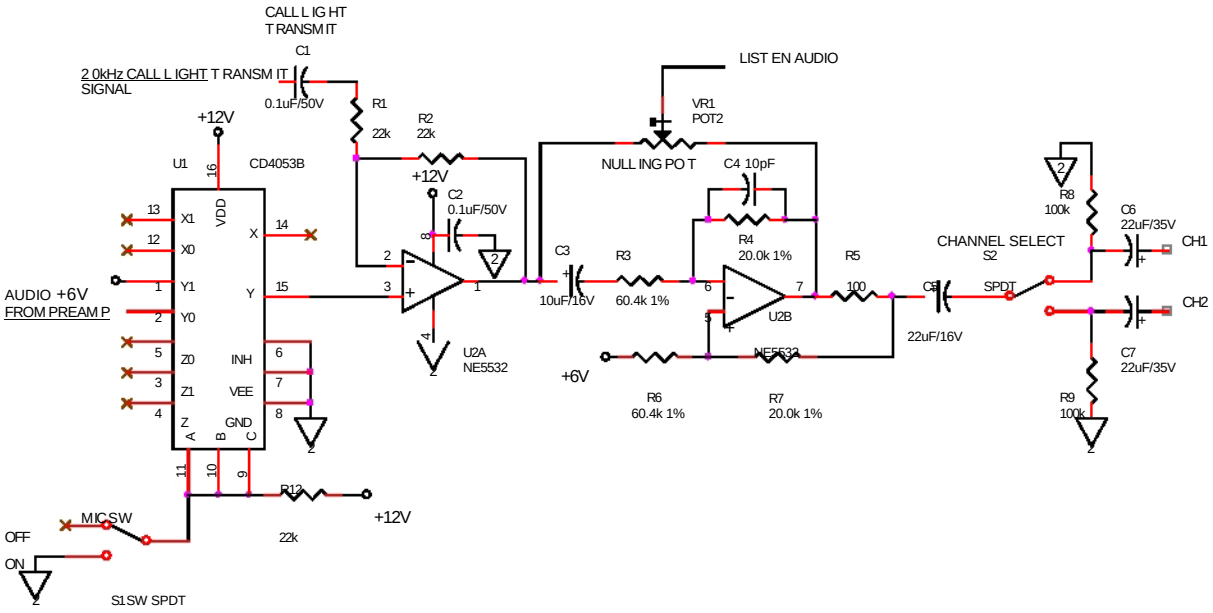
Bilateral Current Source For A Multi-terminal Intercom:

Patent Abstract; A bilateral current source operates as a two-wire to four-wire converter circuit for an intercom system. The circuit provides a high impedance current driver for putting a local voice signal on the common line connecting the intercom stations The same circuit acts as a buffer amplifier for connecting voice signals received on the same line to a listening device such as a speaker. The circuit suppresses any sidetones by preventing the local voice signal from being coupled to the listening device.

My comments: In belt pack stations: the nulling pot may be adjusted to slightly off null to give a pseudo side tone. In master stations, the nulling is maximized and a separate resistor or pot supplies traditional sidetone to the headphone amplifier.

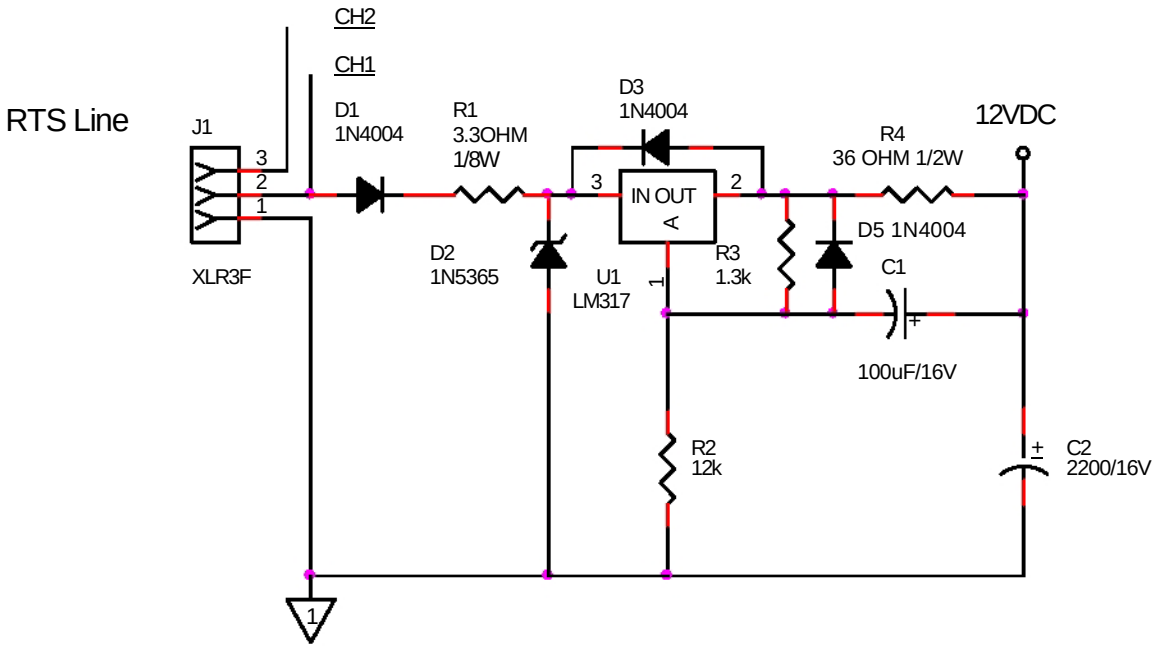
Because of added features, the belt pack BP325 circuitry is similar to above but has additional circuitry.

Bilateral Current Source/Nulling Circuit/ Listen Audio Recovery
Patent # 4,358,644 November 9, 1982



Circuit 3: Rubber Band Regulator

If a user station is listening to channel 2 and has the volume at a moderate to high level, the power amplifier takes more DC current in pulses . Without the Rubber Band Regulator the input regulator passes on the DC current pulses onto channel one and channel two crosstalk could be heard. With the Rubber Band Regulator the DC current pulses are converted to a slowly changing inaudible current.



"Rubber-band" regulator

The LM317 converts the RTS DC line voltage (32VDC to 18VDC) to 12VDC. Adding C1, 100 microfarads, as shown, prevents headphone/speaker audible current surges while on channel 2 from showing up on channel 1. Generally DC power is supplied via channel 1 or what the user station sees as the channel 1 connection. Some newer belt packs have a different setup.

Circuit 4: PS30, PS31, PS60, Regulator (PS8,PS15: similar)

This is a simplified version of one channel of the PS31, the others are similar. This circuit provides current to all the intercom stations that need it and looks like 200Ω to the audio.

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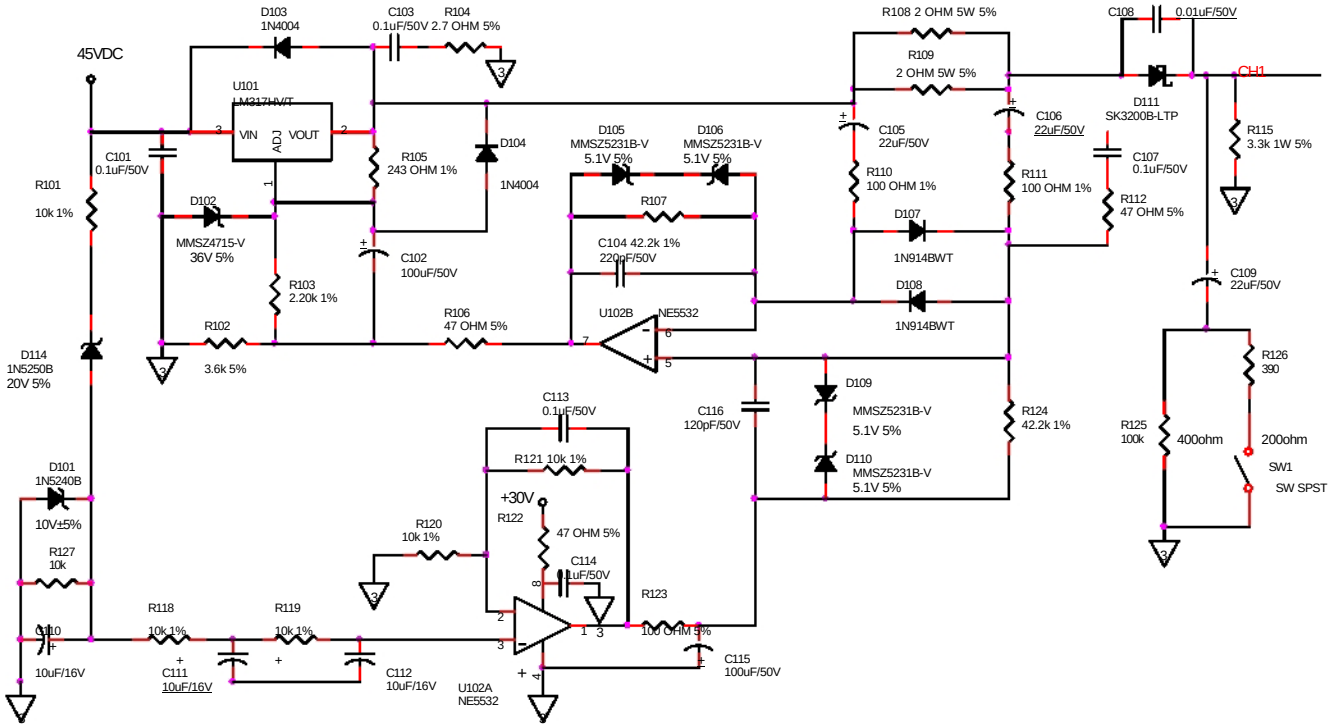
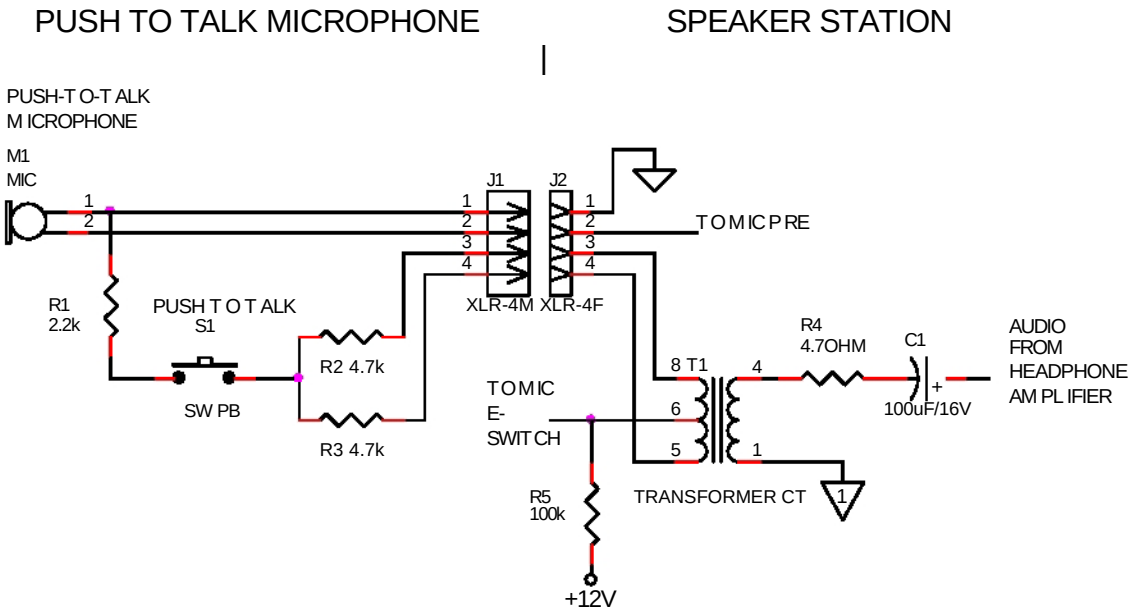


R115 turns on D112 which allows self powered stations to reach the electronics.
D111 protects the electronics from DC power from a separate source.
R108 and R109 combined make up the 1 ohm sense resistor.
The sense signal is carried via C105, C106, R110, R111 to U102B. D107, D108 protect against overvoltages, and also D109, D110. U102B amplifies the sense signal by a factor of 420 (to make the 400 ohms less allowance for some loss). D105, D106 protects against sudden removal of the outside load. They allow recovery in milliseconds. R106 prevents U102B from oscillating due to C102, 100uF capacitor. C102 carries the amplified sense signal to the adjust terminal of U101. The amplified sense signal is repeated at Vout, a low impedance source. The amplified sense signal appears at the left side of R108, R109, and now makes the one ohm resistance appear to be 400 ohms. The 45 volts DC goes directly to U101, LM317HV, and also goes to the string R101, D114, D101, R127, C110. The idea here is to provide a 10 reference voltage for U102B. The reference voltage appears at U102B, pin 7 and on the side of R106 and R103. The voltage at R103 becomes 32 volts at U101 Vout. R106 between U101 pins 1 and 2 sets the current, 1mA, through R103. The 22 volt drop across R103 is added to the 10 volts at U102B pin 7 to give 32 volts DC which goes through the sense resistors and D111 to supply the DC voltage and current (about 1.5 amperes) for the system on Channel 1. The user station supplies a current of ±5mA to create a signal of 2 volts peak to peak. The switch, SW1 sets the impedance at either 200 ohms or 400 ohms.

Circuit 5:

The Special Push-To-Talk Circuit for the Speaker Station. This circuit lets the Push-to-Talk microphone trigger the Speaker Station's mic switch when it is used. When there is a headset plugged in instead, the mic is triggered by a button on the speaker station.

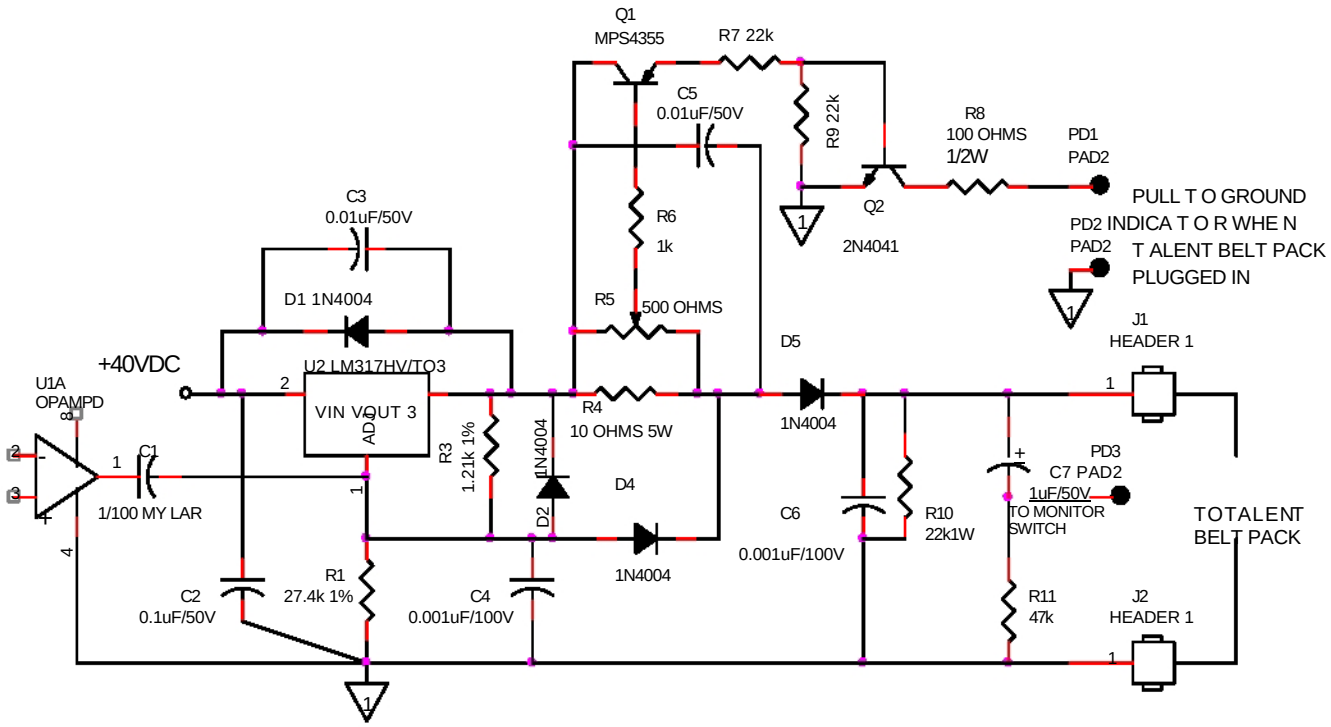


J2 is the headset connector on the speaker station.

The push-to-talk switch in the microphone case grounds both sides of the transformer (the headphones which are normally plugged into J2 are not plugged in because J2 is being used by the push-to-talk microphone). The E-SWITCH is a CD4053 analog switch (controlled digitally). R2 and R3 lightly load T1. The push-to-talk microphone as it comes from Telex's supplier doesn't work as required for this function and has to be reworked to match the diagram, above.

Circuit 6: The IFB Talent Belt Pack Driving circuit

Circuit 6:IFB DC plus Audio driver in the Model 4010 supplies DC and audio to the 4020 IFB Talent Belt Pack receiver. The circuitry in the IFB_828 differs and is used to connect the user belt packs to the matrix. Another simple circuit supplies the non-interrupt audio to the other channel of a two channel receiver.
A signal comes in at U1A pin1, through C1 to the ADJ terminal of U2, LM317. The



impedance of the adjust terminal to ground is just that of R1. The VOUT terminal of U2 follows the ADJ terminal. The signal then goes through R4 and D5 then to the Talent Belt Pack. This Belt Pack draws enough current to turn D5 into a low impedance conductor with a 1 volt or more DC drop. Diodes D! and D2 are recommended by the manufacturer of U2. D4 limits the voltage drop across R4 and R5 to one diode drop or about 1 volt.
A circuit senses the presence of current to the Talent Belt Pack. This circuit consists of R4, R5 R6, Q1, Q2, R7, R9 and R8. Originally it was specified as a relay driver or a lamp driver.
The voltage of U2 VOUT terminal is 27.4 + 1.21 volt DC or about 28.6 volts. The output voltage at J1 is about 27.6 volts lightly loaded, but with a 100mA load is about 26.6 volts.
C7 and R11 take off the audio voltage if present to be monitored from the front panel of the Model 4010. C7, R11 removes the DC from PD3 leaving just the audio. C2 removes the hash and noise on the power supply line. C3 may remove some noise. C4 limits the high frequency from U2, as does C6. R10 turns on D5. R5 provides a trip adjust for the PD1 output. If a relay or DC load is installed
an external DC source must be employed. R10 turns on D5 even if a Talent Belt Pack is not plugged in, and allows C7 to deliver audio to the Monitor Switch.

Sales and /Support Trips (Over the period 1997 to 2005)

San Francisco	Doug Leighton demos the new built pack. A glitch in a test power supply. We discussed a fix on the phone and Doug took care of it.
North Hollywood	Trip to a production at a western bar using RTS 2 wire intercom. One day I visited a client working in the field. I noticed the PS10 lunch box sitting in a van with almost every XLR connector used. It felt very warm to the touch. I asked the client how many stations were plugged in, he said 17. Then I asked how he came up with that number. He said he kept plugging in stations until the power supply quit, then he removed one station. He said the supply was very reliable and it worked just fine with that kind of load.
Burbank	We outfitted a Compact Video television trailer with a 2 wire system including a new Model 801 master station. I visited a Hollywood location which was using the new Compact Video television trailer. That's when I noticed the difficulty the crew was having keeping the intercom sound from the stage director's headset from getting into the actors microphone. A better headset with leakage prevention was still 10 or 20 years away. The fix at the time was to have the stage manager turn his volume down. The crew liked the RTS Intercom.
CBS Hollywood	Dave Brand and I visited CBS to fix a strange problem: when the director pushed a certain IFB button, it would stay in IFB mode. The problem was the Model 802 speaker magnetic field was triggering a reed relay in the IFB panel. The solution was to turn the IFB control panel around 180 degrees, and change the button labels 180 degrees.
Baton Rouge, LA	At a TV preachers venue. RTS had sent them a made-to-order accessory. They didn't read the instructions that said connect it to 12VDC and plugged into 120VAC, which smoked it right away. So RTS made a new one and sent me to Louisiana to help install the new one.
Tennessee	They needed help in getting the RTS intercom into the TV cameras. I flew in got a ride to the venue, fixed the problem, got 2 hours sleep then I was taken back to the airport.

Continues

Sales and /Support Trips (All dates are estimates)

Ft. Worth, TX

The Fort Worth TV station, KDFW, had ordered a large IFB system. Lisa Brown and I installed it. As I recall, we had to make yet another trip to do some more work at that station.

Houston, TX

This was at the NASA WETF facility. This was the venue where the astronauts practiced assembly and repair in space. The working in the pool emulated zero gravity. They had some RTS Model 802 stations, an interface to some belt packs. Their interface to the underwater intercom wasn't quite right, so I fixed it. Later I heard that they installed a whole new custom system.

The NASA WETF Pool

Used to train astronauts in a weightless environment.

Operations Desk

Two Console Mount Stations and an 802 Master Station

Seattle, WA

I was sent to Boeing Aircraft in Washington to specify an expanded intercom system. I flew up to Seattle then took a taxi to the Everett plant. I worked out the new intercom system, then in conversation with one of the users, I found out that a steel door had been closed on one of the intercom cables going into a screen room over the weekend and the PS10 power supply was still powered up. So the PS10 was shorted all weekend. On Monday morning they were pleasantly surprised that when they unshorted the power supply, it immediately recovered with no damage whatever and the system was up and working. The area that all this happened is where a cockpit is connected to a video system and a computer and the system tests various controls and future aircraft. So that was a good test where the PS10 passed with flying colors. By the way short circuit protection was

(Continues)

Sales & Support Trips (Continued)

	one of the design parameters specified by Doug Leighton. I figured his experience in the TV industry guided his thinking. All the RTS supplies have been designed with that philosophy
Rome, Italy	The job in Rome was to figure out a special intercom for a movie studio: Cine Cita. This was a really strange system, but I specified the equipment. Then caught the airplane for Milan.
Milan, Italy	The job in Milan was at the Italian dealers office to take the heat because RTS had bypassed the dealer and sold a large system direct. So I smiled and listened to the dealer's rant which was legitimate, I apologized profusely, by that time my ride had arrived to go to Switzerland.
Lake Locarno, Switzerland	This was a job on a large TV truck that was outfitted with an RTS System that had crosstalk and noises. I worked with the truck engineer and we cleaned up a lot of the problems. Then I got a ride back to Milan and flew back to Burbank.
Provo, Utah	The venue was Donny and Marie Osmonds' studio. The problem was that all the RCA cameras were wired wrong and there was a strong hum in the system as well. I corrected the wiring in the cameras, then found the hum problem in the lighting grid. A vinyl covered cable had its shield accidently earth grounded. Some black electrical tape fixed that problem.
Camden, NJ	This was a trip to RCA's camera shop to talk about putting RTS into the RCA cameras.
New York, NY	This trip was to attend the Emmy ceremony where RTS received an Emmy for the RTS Intercom System Design. Doug and I gave speeches that were well received.
Atlanta, GA	This was an NAB show, one of many, Doug, salespeople and I attended. I gave a paper about putting RTS into TV cameras, which was well received.
Connecticut	This was where Lisa Brown and Mike Berro worked on the RTS system in the ESPN trucks.
La Jolla, CA	This was trip to a Movie theatre with Gene Behrend to check an installation of the box office window intercom. Some training was involved but the intercom worked well.

Sales and Support Trips (Continued)

New York, NY	This was a trip to the Wall Street Journal's office. The complaint was the 24 telephone interfaces that I designed were not working well. Shawn Anderson, myself and another Telex person was on this trip. The solution was to update the TIF2000 schematic and PC board and add a limiter in the 4 wire to special hybrid chip then to the 2 wire circuit. The TIF2000 original specification did not specify 24 telephone calls simultaneously. But the fix worked.
Orange County, CA	This was a courtesy trip to Trinity Broadcast who had an early RTS System, that had a PS50 which was still working after five years or so.
UCLA, CA	RTS donated a bunch of new circuit boards so the TV school could upgrade their RTS system belt packs.

Toronto, Ontario, Canada, Sky Dome: Installation of the Model 848 Matrix Intercom. Installation went well after I cleared up a wiring error. It was very cold outside and very warm inside because the air conditioner wasn't installed yet, and a lot of equipment was running. I was there for two or three days and the only reason, I can think of was that there was more equipment to install or there were a few more bugs to fix. I was required to wear a construction hat & steel toed shoes. We stayed at a wonderful hotel, but at breakfast we had several refills on the orange juice. That added about $30 (Canadian) to the bill.

Minneapolis & Blue Earth, MN, Lisa Brown helped get the production line going.

Norco Facility, California	A test was run on the electronics for the B1 fuel tank inspection system. It passed the explosion proof test. Then some of the atmosphere from the test enclosure was transferred into a glass tube and ignited with a built in spark plug to show that, indeed, the enclosure atmosphere was explosive.

Sales & Support Trips (End)

SPECIAL PROJECTS-1

While we were still in Burbank: ABC Television Remote Belt Packs.
ABC had made a ring-down network for remote operations. They wanted RTS to make a beltpack that was a compatible ring-down belt pack/telephone. In about 4 month's time after delivery of the special equipment, ABC set aside the ring-down system and bought a regular RTS system, Below are three views of the special TRT383 belt pack.

SPECIAL PROJECTS-2

For the B1 bomber aircraft: a fuel tank inspection system that was explosion proof, with back up batteries. The unit was plugged into the power but was totally isolated. The belt packs had to be high impedance, low current. The outside electronics package was painted in military colors with appropriate identification silk screened on it.
The back up batteries were such that the personnel inside the fuel tank had plenty of time to exit the fuel tank. There was some kind of indicator to indicate power loss.

The inside unit (inside the fuel tank) was high impedance, low current, belt pack with a high impedance headset. The connection cables were extra rugged and explosion proof.

SPECIAL PROJECTS-3

For the B2 bomber aircraft: a multi-group intercom system. There could be up to 24 groups, each with their own 24 channel switchbox. The idea was to prevent eavesdropping by any group on any other group. In addition to the inspection teams for the aircraft, there was a remote station at a control tower, and a 24 channel switchbox in the control room so that the person in charge could talk to any group.

SPECIAL PROJECTS-4

All I know about this system is that I saw military style belt packs coming off the production line. It may have been a reorder of the B1 fuel tank intercom.

SPECIAL PROJECTS-5

This project used a large number of Series 17 belt packs in a large passenger aircraft. Each passenger was an ophthalmologist MD (eye doctor) that could listen to a surgeon as he was operating in an special operating room on the aircraft. They also could ask questions at an appropriate time. There was also video coverage of the operation. There were different groups of passenger doctors for each country. The aircraft flew from country to country as a doctor teaching facility. (http://www.orbis.org/) The Series 17: is a single channel miniature lightweight belt pack with a push to talk switch and a listen volume control.

SPECIAL PROJECTS-6

Two Series 17 were used in an isolated special communication system aboard a submarine.

SPECIAL PROJECTS-7

A small intercom system was set up with belt packs and a power supply to perform maintenance on a nuclear reactor. When the belt packs became radioactive, they were made radioactive waste and new belt packs were brought in to replace the old ones. I think a number or reactors used this technique.

SPECIAL PROJECTS-8

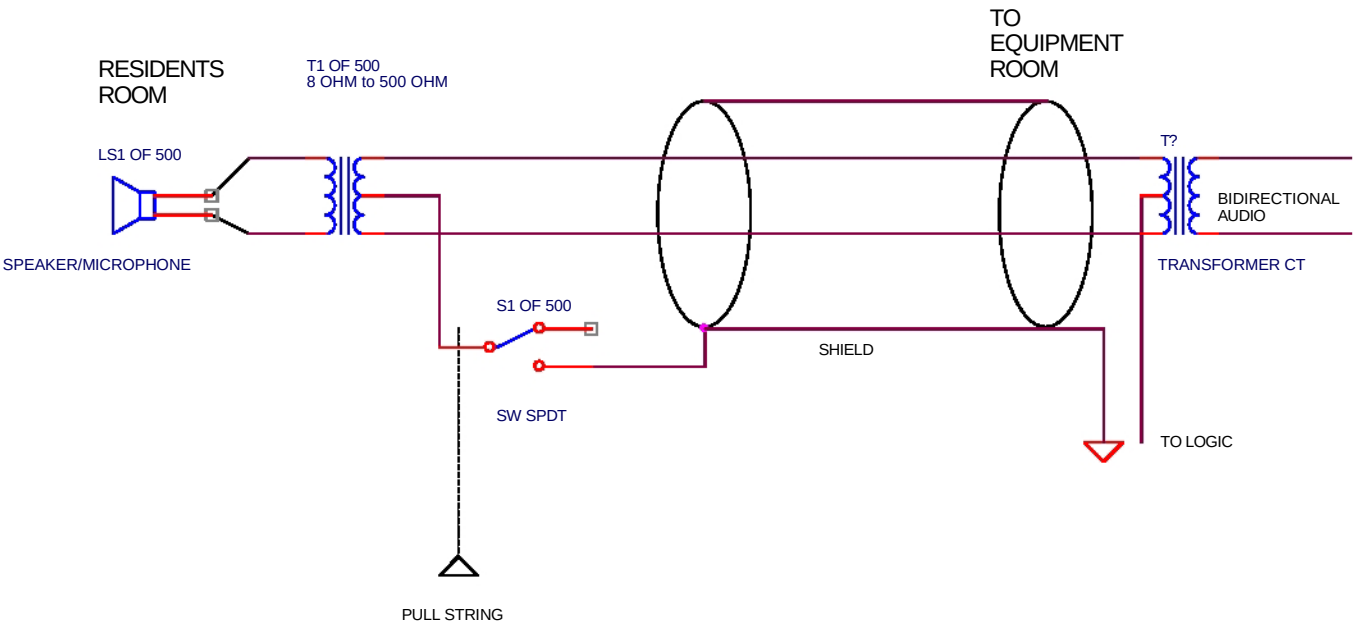
Regents Pointe

Just as we were setting up to design the Model 802, an audio consultant called and said we had to get started on Regents Pointe. We had previously told him we didn't want the job, it wasn't the kind of work we wanted to do. He said nobody else was available and he was counting on us, and also he needed the site wiring diagram right away. This much I knew:

1) It was a 500 station intercom.
2) All the intercoms could be accessed at the main desk.
3) The electronics was to be in a little room not to far from the main desk.
4) The intercom operated as follows: one of the residents would pull a string switch in their room and that would connect them to the front desk (light a pushbutton), and the front desk would be alerted and would push that button to answer the resident.
5) The intercom also worked in the other direction in the front desk could push an "All Talk" button and make announcements over the campus in every room, or press room number button and talk to just that room.

So I had to drop everything and figure out the cabling and draw a schematic and send it to the consultant right away because the construction crew was waiting.

Getting back to Regents Pointe, I figured a shielded two conductor cable to each room would do the trick, so I looked up the Belden number and at least they could buy the cable. Then I had to draw a schematic so the crew could wire up each room. It looked something like this:



Regents Pointe Wiring Diagram

So with this diagram the construction crew could get working and I could design the rest of the 500 station intercom. The details may be on file somewhere at Telex Communications.

A little more about Regents Pointe: It was a magnificent huge campus, suitable for the rich retired residents. Each resident had more than a room, an apartment of sorts. The facility had a large dining room with an advanced kitchen facility with hi-tech ovens and the works. My wife and I ate there one evening, it was superb. The campus had a golf driving range, their own bus service to take the residents shopping, A swimming pool, a gym, a theatre, you name it, they had it. They had their own special care unit for residents that were unwell.

Some years after our installation, the giant call board got replaced with a computer terminal, a much nicer system. The original electronics was still used in the equipment room. Also Regents Points had their own back up power so the communication system worked even during power outages.

The Giant Call Board

One of the electronics system racks.

TV Crews

This is a snapshot of intercom users during RTS Systems start-up days and for some time thereafter. There are several crews in mind, going from small to big. Keep in mind there are variations, these are just instances. Also the personnel listed are usually using the intercom system. I am not sure where the teleprompter operator fits in. Other personnel such as a script person, assistants, utility are not usually on the intercom. Some personnel cover several positions. Also, somehow the program gets recorded, sometimes at the studio, sometimes at the remote site. The IFB is a one way intercom for the talent to receive, director sends.

News Crew: Camera person(s), audio person, director, commentator.

Commercial (Often at retail store) Usually the smallest crew: Camera person, audio person, director, stage director, utility. The director talks to the cameraperson, stage director, sometimes to the audio person, otherwise uses the second channel and an onstage speaker station as a "stage announce". The talent gets cues from the stage director or IFB.

Small Production (and some commercials) Camera persons, audio person, producer, director, stage director, maybe camera switcher (technical director), and maybe lighting person and recording person.

Medium Production Camera persons, video person, audio person/mixer, audio assistant (A2), producer, director, assistant director (commercial coordinator), stage director, camera switcher (technical director), announcer, utility person(s), lighting crew.

Large Production Camera persons, video person, audio director, audio mixer, audio A2, audio crew, producer, director, assistant director(commercial coordinator), stage director, announcer, camera switcher (technical director), video person, lighting board, spotlights, lighting utility, recording person, general utility persons, wireless personnel.

Sports Production Camera persons, video person, audio director, audio mixer, audio A2, audio crew, producer, director, assistant director (commercial coordinator), announcer, announcer color person, camera switcher (technical director), video person, recording person(s), on line editors, instant replay, red hat, wireless personnel, uplink coordinator. The "Red Hat" stands in the playing field, usually with a two wire belt pack or wireless belt pack. The Red Hat's job is to coordinate game play (via game personnel) with television advertisements. The game resumes after the advertisement finishes.

RTS LOGOS

1975 — The company was named from this logo.

Ca 1980

Ca 1990 **RTS SYSTEMS™**

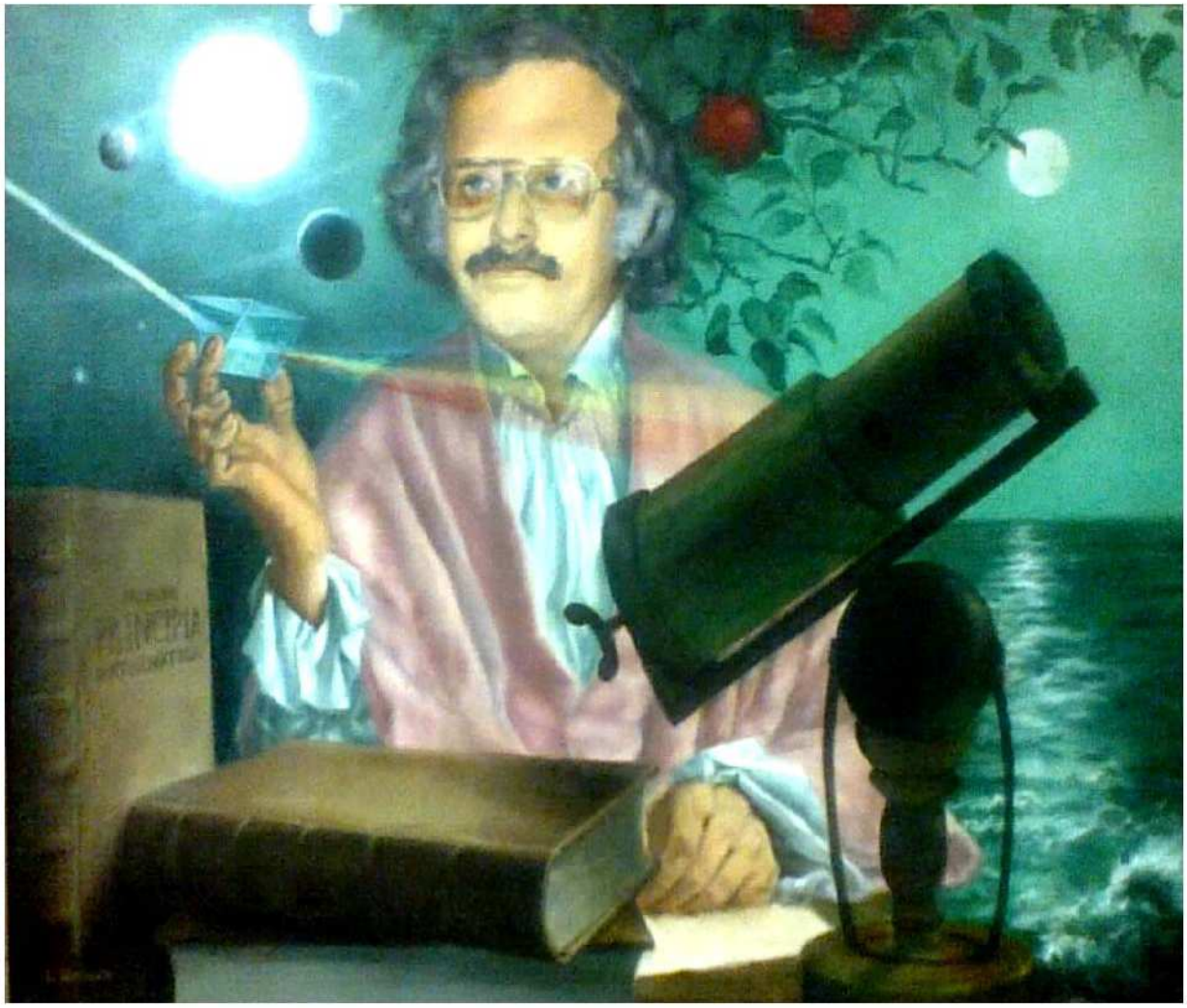
Ca 2000 **RTS™**

SPK300-ASG by ASG/Bexel, Inc. **Photo by Andrew McHaddad**

Shown here is an SPK300-ASG which is an SPK300 upgraded by ASG/Bexel, Inc. 1) Allows LED visual determination of operating state, and 2) provides separate volume control of each of 2 channels, 3) provides easy to use pushbutton operation, 4) provides front panel nulling of both channels, 5) a countersunk screw on left side allows speaker to sit on its side, saving space on a crowded table, 6) It remembers the last channel selected, even with a power interruption. It has an aesthetic appearance as well.

Sir Isaac Hubler

Below: Another oil painting by Lisa Brown: me, Stanley Hubler, as Sir Isaac Newton. (I graduated from UCLA with a physics degree.) Lisa's husband, Mike also has a physics degree, from Cal-State, Northridge. Yes, it's the Mike that helped us get started in the garage.



Stanley Hubler AKA Stan Hubler Biography

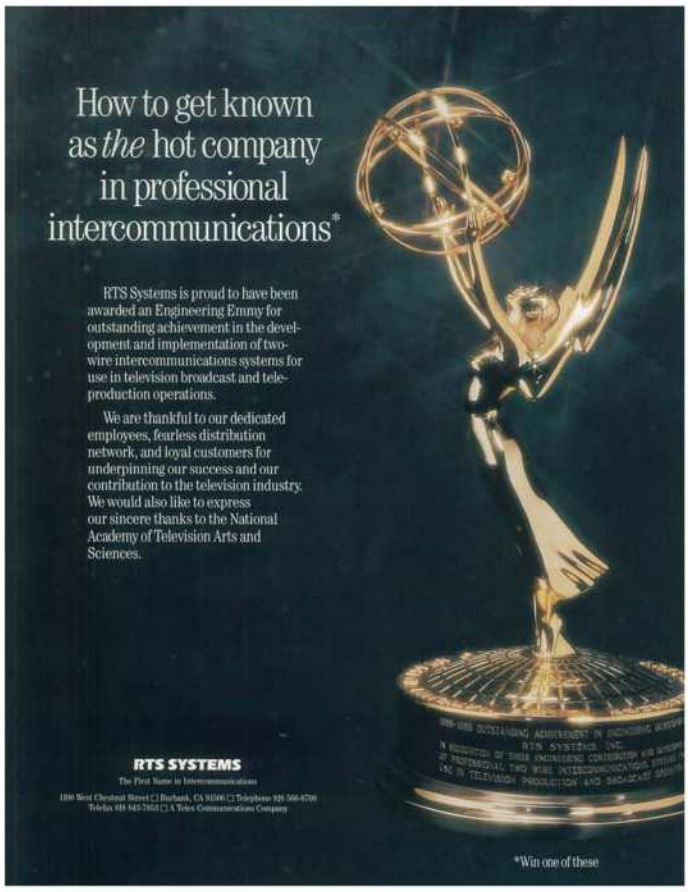
Born in 1933 in Los Angeles.. Served honorably in the US Navy from 1956 to 1960. Graduated from Navy Electronics/Radar School and was #1 in my class. After the Navy, worked as a technician for four years and took physics, algebra, chemistry classes at El Camino college in night school, then transferred to UCLA in 1964 and graduated in 1967 with a bachelor's degree in physics. Went to work in aerospace till mid 1975 when I co-founded RTS Systems. In aerospace I worked on the design of the Spruance Class Navy Destroyers, on the Voyager spacecraft and electronic counter-measurers. At UCLA, I worked in the Phonetics Laboratory where I designed a tape recorder attachment to measure oral air pressure. I designed speaker amplifiers for 6 student tape recorders. Also in the Phonetics Lab, I designed a differential preamplifier for visiting Dr. Hirano, MD who was researching the larynx muscle activity, Later, I built and sent a portable version to Japan for his use there. I wrote a paper for "Working Papers in Phonetics" describing the portable preamplifier. For my senior project, I designed and built a Nuclear Quadrapole Oscillator to detect crystal nuclear quadrapole resonance. To test the oscillator, I grew a relatively large potassium chlorate crystal (about 5/8" cubed) which took me a month to grow in a basement of the old physics building. I devised an integrator circuit for the lab's PDP12 computer and wrote a paper for DECUS. I designed a polar to rectangular converter for the lab. I also worked with a graduate student to design a lip movement detector (during speech). I spent time on my studies which included physics, chemistry, mathematics, biology, Russian, J.S. Bach, History Of The Opera, Shakespeare and Poetry.
After graduation in 1967, I took courses in Feedback Control Theory, Patenting and Marketing, Audio, Technical Writing, Auto-Cad, and Probability and Statistics.
Before the Navy, I worked a year in Lockheed's machine shop on a mill and a precision drill press then a year and a half at another company, building and wiring 50 kilowatt motor generator sets for powering aircraft during ground maintenance. I also assembled and wired a dimpler heating controller for the Skunk Works. This was used to preheat riveting spots on aircraft wings that used titanium metal which is brittle at room temperatures, but the wings were superb at supersonic speeds and the resulting high temperatures.

In 1982 I married the love of my life, Pamela. We were married for almost 30 years until cancer took her away from me. Pamela was not only beautiful, but very, very smart and was an executive for a business training operation. Around 1990, Pamela accompanied me, and a bunch of RTS and Telex personnel to New York for the RTS Emmy award (for the technology that Doug and I created). Later in 2010 I won another Emmy for the belt pack design (an individual award versus an Emmy for RTS Systems). Pamela also went with me to the yearly NAB shows. On our honeymoon, we spent time in Lake Tahoe, California, where we skied, then on the return, a stop at Vacaville, California which had a small airport and a train to pick up the plane travelers and take them to a restaurant. There was a wig-wag signal next to the restaurant that I designed the electronics for about 25 years before and it was still working!. Then we toured San Francisco's bay area, stopping at Ghirardelli's chocolate factory, yum-yum!. Next stop: Monterey bay where we picked up a 4 foot stem of delicious artichokes at a roadside stand, they were yummy, too!. Then we went southerly down the beautiful Pacific Coast highway and to home.

PART2: Doug Leighton's section: The Emmy, Shows, Marketing, Personnel

Doug Leighton Holding the Emmy

Ad showing the 1988-1989 Emmy


How to get known as *the* hot company in professional intercommunications*
RTS Systems is proud to have been awarded an Engineering Emmy for outstanding achievement in the development and implementation of two-wire intercommunications systems for use in television broadcast and teleproduction operations.
We are thankful to our dedicated employees, fearless distribution network, and loyal customers for underpinning our success and our contribution to the television industry. We would also like to express our sincere thanks to the National Academy of Television Arts and Sciences.
RTS SYSTEMS
*Win one of these

How to get known as *the* hot company in professional intercommunications

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NAB Show in Las Vegas Nevada, Circa 1980-1990

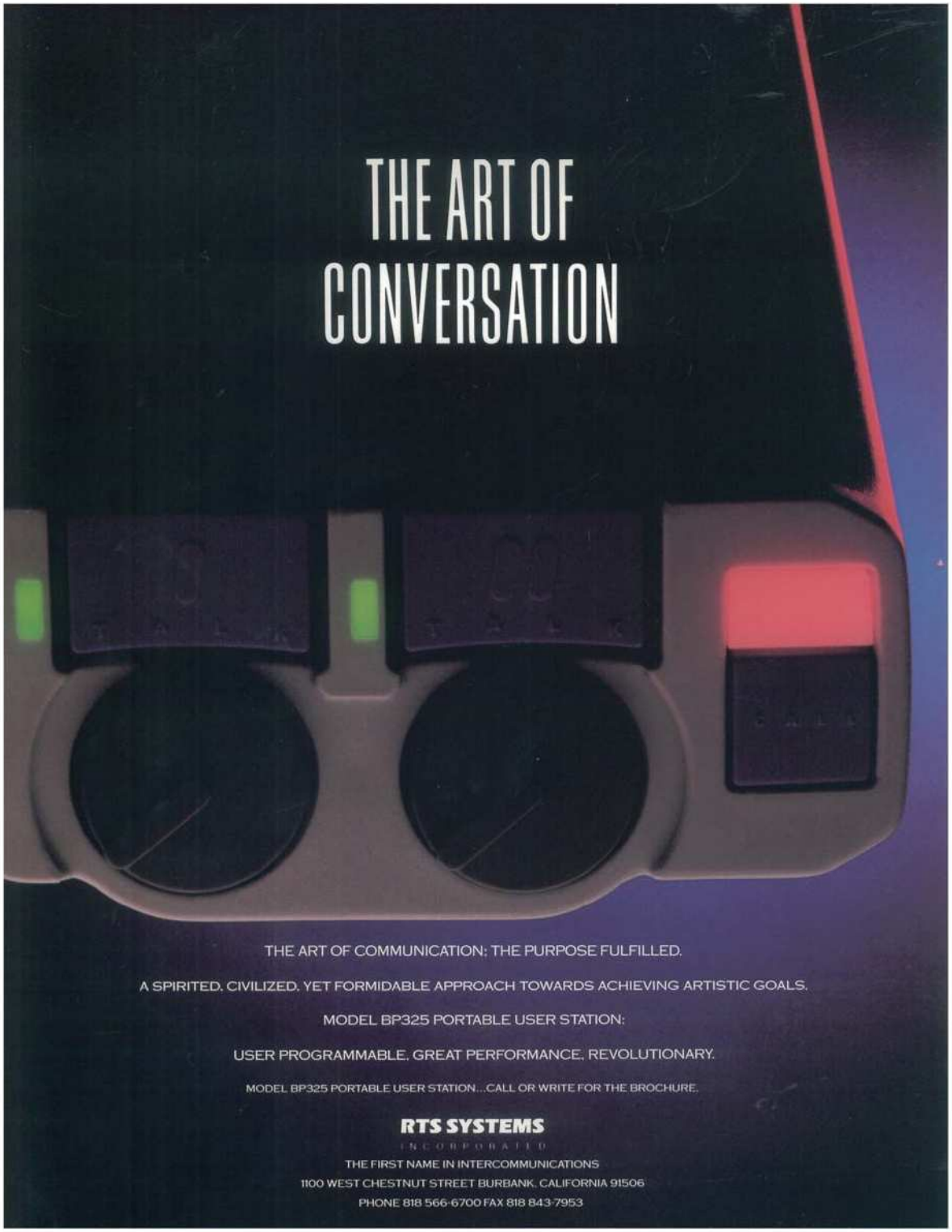
This was our first NAB show with Compact Video. It was seen as a combined effort to promote not only RTS gear but Compact Video at the same time.
This is the big show annual show that allows prospective customers to see, touch, try the new equipment. An important marketing event. This picture taken probably in the 1980s.

Doug Leighton in a studio

Next: Marketing: Three Ads for the BP325

Then Personnel

INTRODUCING OUR NEW BP325
USER PROGRAMMABLE.
MICROPROCESSOR ASSISTED.
LIGHTWEIGHT CONTOURED BODY.
KILLER CIRCUITRY.
GREAT SOUNDING.
AFFORDABLE. REVOLUTIONARY.
PORTABLE INTERCOM USER STATION.
OR, IN A WORD:
WOW!
MODEL BP325 PORTABLE USER STATION
PLEASE CALL OR WRITE FOR THE BROCHURE.
RTS SYSTEMS
INCORPORATED
THE FIRST NAME IN
INTERCOMMUNICATIONS
1100 WEST CHESTNUT STREET
BURBANK, CALIFORNIA 91506
PHONE 818 566-6700 FAX 818 843-7953


THE ART OF
CONVERSATION
THE ART OF COMMUNICATION: THE PURPOSE FULFILLED.
A SPIRITED, CIVILIZED, YET FORMIDABLE APPROACH TOWARDS ACHIEVING ARTISTIC GOALS.
MODEL BP325 PORTABLE USER STATION:
USER PROGRAMMABLE, GREAT PERFORMANCE, REVOLUTIONARY.
MODEL BP325 PORTABLE USER STATION...CALL OR WRITE FOR THE BROCHURE.
RTS SYSTEMS
INCORPORATED
THE FIRST NAME IN INTERCOMMUNICATIONS
1100 WEST CHESTNUT STREET BURBANK, CALIFORNIA 91506
PHONE 818 566-6700 FAX 818 843-7953

INTRODUCING
OUR NEW
MODEL BP325
PORTABLE
USER STATION.
USER PROGRAMMABLE
WITH A POWERFUL
MICROPROCESSOR,
LIGHTWEIGHT
CONTOURED BODY,
AND GREAT
SOUNDING
CIRCUITRY.
THE FACE OF INTERCOM
AS IT SHOULD BE
USER
ACTIVATED!
WORKS ON ONE
OR TWO CHANNELS
AND INCLUDES
CALL SIGNALING,
MOMENTARY/
LATCHING SWITCHES,
PROGRAM INPUT,
CENTRAL-POINT
MIC TURN-OFF,
AND MUCH MORE.
MODEL BP325:
USER ACTIVATED
FOR OPTIMUM
PERFORMANCE.
PLEASE CALL
OR WRITE
FOR DETAILED
LITERATURE.
RTS SYSTEMS
INCORPORATED
THE FIRST NAME IN INTERCOMMUNICATIONS
1100 WEST CHESTNUT STREET BURBANK, CALIFORNIA 91506
PHONE 818 566-6700 FAX 818 843-7953

Farewell to RTS-Chestnut Party at Chez Leighton

Linda Rico	Debbie Fritz		Doug Leighton	Pam Hubler	??? ???	Sue Seidenglanz

Farewell to RTS-Chestnut Party at Chez Leighton

?? Steve ???? Vicki Sue Stephanie Al Carmen Blanca Martha Mike ??
?? Farkas ???? Bertrand Seidenglanz Snow Salci Galicia Hernandez Gomez Perry ??

Bob Ringer and Christmas Tree

Friend and Doug Leighton

Al Salci

Bill Neigbors

? Ron Booth

Dave Richardson

Stan Hubler Emmy Doug Leighton

Karen Hultgren Doug Leighton Dave Brand Stan Hubler Lisa Brown

1100 West Chestnut Street Burbank California

The engineering crew:. Stan Hubler Fiona Campbell Charlie Neuman Jerry Barnett
Muriel Van Auken Ron Booth (Unkown Lady) Bill Eisenberg Ron Kelley Dan Register Mike Berro

Lisa Fuller Sue Seidenglanz Melanie

Debbie Fritz Linda Rico Sue Seidenglanz

Linda Rico, Kim Murphy Stan Hubler Doug Leighton

Dave Richardson Shelley Harrison Jean Luc

Talal Ali Youssef | Carmen Galacia | Giovani Moraes | Martha Gomez

March 28, 1991: Becky Evans at a company Picnic. Becky was a long time, super production worker, product tester & more. Becky provided the two group pictures on page 74 with most of the employees wearing the “Emmy” shirt.

Douglas Leighton Biography

Currently on staff with Panasonic System Communications Company, Doug Leighton began his tenure as Product Marketing Manager for DVCPRO50 and DVCPRO HD products (Cameras and VTRs) through April of 2001, at which time he was assigned the post of Los Angeles Area Account Manager, and in 2010 moved over to Senior Partner Sales Manager, adding Colorado and Utah to his territories. In this position he is responsible for sales and support of Pro Video, Pro Display and Projectors. In supporting the reseller network, he is responsible for a considerable quota, as well as keeping the resellers and their customers up to date on all three product lines.

Prior to Panasonic he served as Regional Manager for Scitex Digital Video in Los Angeles and Director of Sales for Preferred Video Products in Burbank, CA. During his tenure at ASC Audio Video Corp., he built a marketing department and developed a strong product and company image. His stature in the pro audio industry was evidenced by his work at 360 Systems, creating new products and a vastly improved company image.

But the long-term effort was fulfilled with a pair of Technical Emmy Awards for his exceptional work over a 16-year stint as President and then Vice President Marketing for RTS Systems, a worldwide leader in professional intercommunications systems. He was the co-founder of the company and was directly responsible for the wide range of products, company image, and collateral materials. He created a market for sophisticated intercom products—where one did not previously exist. He was also heavily involved with new product specifications, custom products, sales and systems designs. The company sold products worldwide to the entertainment, industrial, corporate. Military and commercial markets. The company grew steadily to $7 million in yearly sales and was purchased in 1989 for $12 million.

Previously he was involved in television production. Working in all aspects of crew operations on thousands of shows for over 12 years provided a substantial base of practical experience.

Educational background includes a Bachelor of Arts Degree from San Francisco State University in Radio-Television-Film.
He was awarded two Technical Emmy Awards for his work at RTS Systems.
His is a board member of SMPTE, West Coast.
He is an Associate Member of the prestigious American Society of Cinematographers.

Next: An addendum: Doug Leighton's conference call describing a recent Emmy award.

Addendum: January 2011

Hi everyone,

First let me describe what happened here. The Technical Emmys Awards banquet - an annual event - was held at the Venetian hotel last Thursday night during the CES show. About 350 in attendance and quite the mix of video and audio companies were there to receive their awards, including Dolby Labs, Avid, and yes, Panasonic won an award for developing BluRay. Sir Howard Stringer received a lifetime achievement award.
So these are the Technical Emmys. This is not the same as an Emmy for acting, directing, or producing. A technical Emmy is an award that is given to companies that develop products that have an impact on the production business—products that redefine the way production is done and make a significant improvement in the day to day operations. And I was awarded one—along with 3 other individuals.
This is the second Emmy Award that is now sitting on my mantle. The first one was given to the company I founded, RTS Systems. That Emmy was in1989. This Emmy was given to me as an individual—It represents my contribution to the industry relating to the work and accomplishments I did at RTS. Quite the recognition, it's rare for individuals to receive Emmys. So this adds some serious luster to the prize. .
You're probably wondering how all this came to be. Back in the previous century, I was a free lance operator in the television production business. I worked on 1000 + shows and commercials over the years, in every crew capacity: audio, video, camera, maintenance and so on. -- One of the things that was problematic was the intercom system. Junky telecom stuff - retard coils and carbon mic headsets. A far cry from the higher end gear like cameras and VTRs and video switchers.

I took a staff position as audio mixer on the Merv Griffin show which gave me lots of free time do start up a company. Of course, I knew nothing about starting a company but I knew I had the passion and the diligence to make something happen. So I decided to design and create a system that would be better than the current offerings. Of which there were none. They were all hand made from telephone gear.
I'm not a design engineer but I had two years of engineering in college and I discovered a guy named Stan Hubler. He was working in aerospace and really knew his electronics and physics. Quite the brainiac in fact.

In fact, he wanted to know if I had a business plan. Well of course not, but I did know what we needed to do and managed to convince him that with his expertise and my ideas we could do this. Within a matter of months, together we crafted the basis for a system that other electronic design engineers told us would not work. We proved them so wrong.

Basically, we needed to push two channels of bi-directional audio signals down three wires - using standard mic cable. This means laying audio over power lines. Usually the impedance is just a few ohms, which means you cannot have audio—it would not work. We went against this conventional wisdom by floating the audio over 32 volts at 200 ohms. Stan called it a "Virtual Impedance". Probably the first time the term "Virtual" gained popularity. At least in our world. Most importantly the idea really worked. We could put 100 user stations on a common line without it loading down in level.

But the circuitry is just half the story. We needed some super rugged packaging that could take a beating. I Did that! We also realized that we needed to bring the image of intercom up from the lower levels of the broadcast equipment food chain to something as much appreciated as it was greatly needed. So we came up with some very nice photography, brochures and advertisements and created an image for the product that was first class. As a result we could charge more money. Kinda like Apple. Really. Customers balked about the price but they bought it anyway. Why? We had become the de-facto standard of the production and broadcast industry. Once you get the lion's share of the business you become the "Kleenex" of your product category. Above-the-line personnel and below-the-line staffers insisted on their productions be equipped with RTS. Not Clear Com, not anyone else. We were the hot ticket.

In starting a company on a shoestring we were living on my Merv Griffin salary to pay the bills. And as all upstart companies we filled the garage with parts and people and assembled and tested and shipped out of North Hollywood. We stayed in the garage for about 3 years and finally expanded to an outside office so to step up product development and production.

Cut to the next step. Ran out of money to grow the company. Cut to the next step. Sell to the highest bidder. Ah, a company in the business, and one of our best customers. Compact Video was one of the fastest growing, hottest companies in the television rental business. They took us under their wing, fed us lots of money for growth and we hired sales people, and engineers and production staffers. At one point we were 80 strong, excluding admin, accounting and HR. We had over 40 products. We built everything in Burbank and sold it around the world. Our customers were not only television production, but aerospace, industry and entertainment.

In 1989 Compact Video sold RTS Systems to Telex Corporation in Minn. Several years later I resigned my post. Took some time off, and re-launched my career working for various audio and video companies, and finally in 1999 I joined Panasonic Broadcast as product marketing manager for DVCPRO50 and Plasma. Two years later I moved into sales.

And since that time I've been to any number of customers' sites and so many times I see RTS Systems equipment in place. Some of it very recent, some of it quite older and some it I'm sure we built it in the old garage. Still working, still standing strong. Enduring the rigors of time. Makes me proud. By the way, about two years ago, Telex sold their company (and RTS) to Bosch, security systems division, a fine German company. I have one of their dishwashers.

More pictures: next page.

RTS employees Celebrating the Emmy with special sweaters in the sun, March.28,1991.

Back Row:
Dave Richardson, Ron Booth ,Henry Sanchez, Burt Swain, Ed Fritz, Nate Lee, Kathy Colon, Karen Hultgren, Jesse Martinez, Melanie Harrison, Robert McKinley
Middle Row:
Lisette Roggenback, Shirley Duebber, Olivia Alvarez, Angel Garcia, Francie Walker, Gary Howell, Carmen Galicia, Talal Aly-Youssef, Kim Murphy, Giovani Morales, Kirkor Kirkorian
Front Row:
Becky Evans, Ray Kallas, Inga Sabo, Doug Leighton, Stan Hubler, Laura Stotts, Blanca Hernandez, Martha Gomez, Randy Cruz, Lisa Brown

RTS employees Celebrating the Emmy with special sweaters in the shade. March 28, 1991

Back Row:
Kirkor Kirkorian, Lisa Brown, Dave Richardson, Karen Hultgren, Nate Lee, Ron Booth, Doug Leighton, Melanie Harrison, Burt Swain, Robert McKinley, Kathy Colon, Gene Behrend
Middle Row:
Henry Sanchez, Becky Evans, Shirley Duebber, Giovanni Morales, Carmen Galicia, Kim Murphy, Francie Walker, Olivia Alvarez, Blanca Hernandez, Martha Gomez, Angel Garcia, Lisette Roggenback, Dave Brand
Front Row:
Gary Howell, Randy Cruz, Ray Kallas, Talal Aly-Youssef, Jesse Martinez, Ed Fritz, Stan Hubler, Inga Sabo Laura Stotts

Rear Cover

A Saga of RTS Systems, The Intercom Company

1988~1989 OUTSTANDING ACHIEVEMENT IN ENGINEERING DEVELOPMENT

IN RECOGNITION OF THEIR ENGINEERING CONTRIBUTION AND DEVELOPMENT OF PROFESSIONAL TWO WIRE INTERCOMMUNICATIONS SYSTEMS FOR USE IN TELEVISION PRODUCTION AND BROADCAST OPERATIONS